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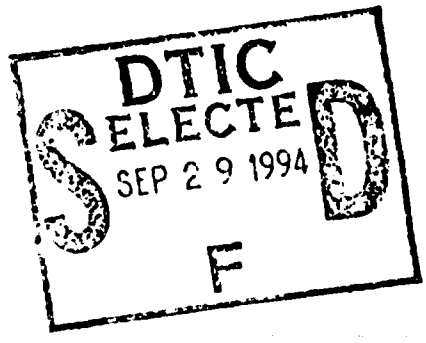

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DEFECTIVE PRICING: AN ANALYSIS OF FACTORS AFFECTING SUSTENTION RATES AND DISPOSITION TIMES

THESIS

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AFIT/GCM/LAS/94S-5

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DEFECTIVE PRICING: AN ANALYSIS OF FACTORS AFFECTING SUSTENTION RATES AND DISPOSITION TIMES

THESIS

Presented to the Faculty of the Graduate School of
Logistics and Acquisition Management of
the Air Force Institute of Technology
Air University
In Partial Fulfillment of the
Requirements for the Degree of
Master of Science in Contracting Management

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Abstract

Defective pricing occurs when contractors fail to disclose current, accurate, and complete cost or pricing data in their proposals. Failure to submit valid data entitles the government to a refund in the amount of overpayment. With the current backlog of overage defective pricing cases and the continuing decline in sustention rates, a better understanding of the factors affecting timely and successful recoupment of defective pricing funds is needed. This research identifies factors which significantly affect sustention rates and disposition times and presents models to predict both rates and times. Factors were identified through a literature review and interviews with defective pricing experts. Analysis of variance (ANOVA) was used to determine the statistical significance of the identified factors. ANOVA results indicated that the following factors have the strongest impact on both rates and times: alleged defect amount, number of issues, legal complexity, method of disposition, identity of prime contractor, product center, and interest. The models developed explain 73.4% and 48.5% of the variation in sustention rates and disposition times, respectively. Recommendations for improving sustention rates and disposition times based on the research findings are also included.

DEFECTIVE PRICING: AN ANALYSIS OF FACTORS AFFECTING SUSTENTION RATES AND DISPOSITION TIMES

I. INTRODUCTION

Background

In response to several 1950s General Accounting Office (GAO) reports which verified substantial overcharging by government contractors, Congress passed the Truth in Negotiations Act (TINA) in 1962. The Act was designed to place government negotiators on equal footing with their contractor counterparts by requiring contractors to submit cost or pricing data used in preparation of their proposals (IG, 1993:1-1). Cost or pricing data is defined as "all facts that, as of the date of agreement on the price of a contract (or the price of a contract modification), a prudent buyer or seller would reasonably expect to affect price negotiations significantly" (10 U.S.C. §2306a(g)). Failure to disclose current, accurate, and complete cost or pricing data constitutes defective pricing and entitles the government to a reduction in the contract price in the amount of the defect.

Despite the passage of TINA, defective pricing and the resultant overpricing remain significant and widespread (US GAO, Dec 1992:7). During fiscal years 1987-1991, the Defense Contract Audit Agency (DCAA) identified $3.67 billion of defective pricing, with approximately one of every three audited contracts being defectively priced (US GAO/NSIAD-92-184FS, May 1992:3). In addition, the alleged defective pricing amounts, especially in the area of subcontract defective pricing, have generally increased in each successive year (US GAO, Mar 1991:3).

Defective pricing remains as widespread today as it did thirty-five years ago because of the inherent difficulties in interpreting TINA. Contractors, contracting officers, the

courts and boards of contract appeals continue to struggle with such issues as the definition of "cost or pricing data," the required format for data submission, the extent of government reliance on the defective data, and the quantification of the price reduction. The continued problems with defective pricing have necessitated aggressive oversight by the Department of Defense Inspector General (DoD IG), GAO, and Congress. These agencies have carefully monitored DoD organizations to ensure effective handling of defective pricing cases. Their two primary concerns associated with defective pricing are the times required to settle cases and the amounts of money returned to the government.

Disposition Times

To increase the priority given to defective pricing cases, DoD directives classify a defective pricing case as overage if it has not been settled within one year from the audit report. Despite the directive, approximately 50% of the defective pricing audits in fiscal year 1991 were overage, with some taking well over four years to settle (US GAO, 1993:26). Furthermore, the time period for settlements is tracked by DoD from the *latest* audit report, rather than the initial. Defective pricing settlements may involve several supplemental audit reports to incorporate changes to audit recommendations as a result of contractor and contracting officer comments. If the time required for settlement is tracked from the initial audit report, the disposition times cited above would increase significantly. In fact, the cases examined for this research showed that only 27% were settled within one year, with the average taking 2½ years. In order to capture the total time spent resolving a defective pricing case, this thesis uses the lengthier definition: ***disposition time*** is the time between the issuance of the initial defective pricing audit report and the contract modification which implements the defective pricing settlement with the contractor. Due to DoD's poor historical record of meeting established disposition timelines and the heightened attention by oversight organizations, this research examines the underlying factors that inhibit or foster timely disposition of defective pricing cases.

Sustention Rates

DoD agencies are measured not only on their ability to settle cases in a timely manner, but also on their ability to sustain the auditor's recommended price adjustment. The Deputy Inspector General's testimony before the Senate Committee on Governmental Affairs expressed his concern over the continuing decline in DoD's sustention rates (Senate, 1992:15). *Sustention rate* is the percentage of the audit's final recommended price adjustment (RPA) that is sustained during negotiations or litigation. DoD's sustention rates have steadily declined from 49% in fiscal year 1988 to an all-time low of 40% in fiscal year 1992 (US GAO, 1993:12). Recommended price adjustments were not sustained due to a number of general factors including legal opinions and litigation decisions, global settlements, non-reliance of the government on the defective data, inappropriate contracting officer determinations, contracting officer disagreement with auditor's recommendations, audit errors, lack of management commitment, and lack of experience and expertise of contracting officers (IG, 1990:11; US GAO, 1993:12-18). Due to the high visibility of declining sustention rates, the DoD IG has recommended an analysis of the major factors affecting sustention performance (IG, 1990:15). This thesis examines the underlying factors that inhibit or foster successful recovery of defective pricing funds.

Specific Problem

With the exception of a small number of GAO and DoD IG studies, no research has been conducted to identify or validate factors that significantly impact sustention rates or disposition times. This thesis attempts to fill that void. The purpose of this research is to identify factors which significantly affect sustention rates and disposition times and determine if valid models can be developed to predict the relationships between these factors and sustention rates and disposition times. With last year's backlog of $1.8 billion in defective pricing cases (US GAO, 1993:28) and continuing manpower reductions, a

better understanding of the time required to resolve cases and the expected return on effort is needed.

Research Objectives

This research attempts to provide a better understanding of the underlying factors inhibiting or fostering timely and successful recoupment of defective pricing funds. More specifically, the research objectives are to:

(1) Identify factors that are presumed to affect sustention rates of defective pricing cases.

(2) Identify factors that are presumed to affect disposition times of defective pricing cases.

(3) Determine which factors identified in Objectives 1 and 2 explain the greatest variation in sustention rates and disposition times.

(4) Develop and validate a model to predict sustention rates using factors identified in Objective 3.

(5) Develop and validate a model to predict disposition times using factors identified in Objective 3.

Scope

This research attempted to analyze all defective pricing cases resolved between 1 March 1991 and 31 March 1994 by three of the Air Force Materiel Command (AFMC) product centers: Aeronautical Systems Center (ASC) at Wright-Patterson AFB, Space and Missile Systems Center (SMC) at Los Angeles AFB, and Electronic Systems Center (ESC) at Hanscom AFB. In total, 118 cases, representing approximately half of the total AFMC defective pricing case load during that three year time period, were analyzed.

Overview of Subsequent Chapters

Chapter 2 reviews existing literature in the area of defective pricing. It explores current interpretative issues being addressed in the courts and boards, procedural aspects concerning the disposition of defective pricing cases, current policy issues, and identifies

some potential causes of low sustention rates and lengthy disposition times. From this review, an initial set of factors presumed to affect sustention rates and disposition times was generated.

Chapter 3 describes the methodology used in the research. It describes the interview process used to screen the set of factors identified in the literature review. It also describes the data collected to represent the factors validated by experts interviewed and the analysis of variance techniques used to determine which of those factors explain the greatest variation in sustention rates and disposition times. Finally, the multiple linear regression procedures employed in model building and evaluation are described.

Chapter 4 presents the results of the research. It first describes the results of the interviews conducted with experts in defective pricing. Analysis of variance results are then presented which identify the factors most associated with sustention rates and disposition times. Finally, multiple linear regression models which predict sustention rates and disposition times are presented.

Chapter 5 summarizes the thesis research, discusses the factors which provide the best overall explanation of sustention rates and disposition times, provides general conclusions and findings, recommends areas for improvement, and suggests ideas for future research.

II. LITERATURE REVIEW

Overview

This chapter provides an overview of defective pricing and discusses the legal, procedural, and policy issues which contribute to low sustention rates and lengthy disposition times. The chapter begins with a historical look at the Truth in Negotiations Act and examines the specific elements that the government must prove to establish defective pricing. The board and court cases summarized in this section highlight the difficulties in enforcing TINA. Next, the process of detecting and resolving defective pricing cases, from initial audit through final disposition, is presented. Critical policy issues and a summary of past research are discussed last. The chapter concludes with a listing of specific factors, derived from this literature review, that are presumed to affect sustention rates and disposition times. This set of factors forms the foundation from which the remaining research is conducted.

Truth In Negotiations Act (TINA)

Before TINA was enacted, government contracting officers relied on the expertise of outside consultants and data voluntarily submitted by the contractor to determine if a contractor's price was fair and reasonable. Needless to say, contractors had little incentive to submit cost or pricing data that would assist the government in its negotiations (Solimine, 1993). This environment created a perception that negotiations lacking adequate price competition presented opportunities for unreasonable prices and excessive profits (Shirk and Greenberg, 1984:184). Recognizing the government's vulnerability, legislative changes designed to correct this problem began in 1959 and culminated with the passage of the Truth in Negotiations Act in 1962.

TINA was enacted to protect the government against inflated prices by requiring contractors and subcontractors to submit cost or pricing data for their proposed prices exceeding $500,000 and certify that the data are current, accurate, and complete. Submission of certified cost or pricing data is required unless the contracting officer determines that one of four exceptions applies. The four exceptions are: (1) Contract price is based on adequate price competition; (2) Price is based on established catalog or market prices of commercial items sold in substantial quantities to the general public; (3) Price is set by law or regulation; or (4) Data submission is waived by the Agency Head in exceptional cases (10 U.S.C. §2306a(b)). If none of the exceptions apply and defective data are found, TINA provides a contractual avenue for recouping overpayments without prolonged litigation (Boyd, 1993:4).

The attitudes and perceptions regarding TINA have changed dramatically over the last thirty years. The period from 1962 until the early 1980s was an "age of innocence," when audit issues encountered were simple and case law was generally predictable. Next came the age of pricing "horror scandals." Public outrage of overpriced spares in the early 1980s led to the creation of a fraud, waste, and abuse hotline and an increased emphasis on the deterrence and punishment of overpricing on government contracts. While these horror stories were generally not related to defective pricing, defective pricing nonetheless received heightened attention. In the mid-1980s, both the number of DCAA personnel committed to defective pricing and the sophistication of their auditing increased. This stricter enforcement of TINA led to the age of "active resistance" by contractors which continues to date (JAG School, 1992:4). This environment also led to the passage of several significant amendments to TINA, a law which had remained virtually unchanged for twenty-five years.

Amendments

In an effort to encourage faster resolution of defective pricing cases and put "teeth" into the consequences, the 1985 amendments to TINA required the contractor to pay interest on the amount of overpayment. It also provided for a penalty assessment, in addition to the interest, if defective data were knowingly submitted (Sec. 934 of DoD Authorization Act for FY 1986, P.L. 99-145).

The following year, TINA was again amended due to renewed concern over apparent overcharging (IG, 1993:1-2). These amendments provided the first statutory definition of cost or pricing data and limited the circumstances in which a contractor can assert an offset against a defective pricing liability. They expressly eliminated certain contractor defenses that had historically been allowed by the courts. Assertions that the defective data did not cause an increase in price because the contractor was in a superior bargaining position or was the sole source can no longer be used in defense of a defective pricing allegation. Similarly, defenses that the contracting officer should have known that the data were defective, that the contractor failed to execute the required certification of cost or pricing data or that the contract was awarded on a bottom-line price agreement were also eliminated (Sec. 952 of DoD Authorization Act for FY 1987, P.L. 99-500).

Phase 1: Burden of Proof

Resolving a defective pricing allegation is a two-part process. The first phase is the determination that defective pricing occurred and the government is entitled to a reduction in the contract price. The second phase is the quantification of that reduction. To establish entitlement to a reduction, the Government bears the burden of proof and must address the following proof elements (DCAA, 1993:1401):

(1) The data in question meets the definition of cost or pricing data.

(2) Current, accurate, and complete data existed and were reasonably available to the contractor before the agreement on price.

(3) Current, accurate, and complete data were not submitted or disclosed to the government negotiator.

(4) The government relied on the defective data in negotiating with the contractor.

(5) The government's reliance on the defective data caused an increase in the contract price.

Since refutation of any of these proof elements constitutes a valid contractor defense, each element has been the subject of significant controversy in the boards and courts. The following summary of the case law for each element is presented to highlight the inherent complexities in resolving defective pricing cases in a timely and effective manner.

Proof Element 1: Defective Data are Cost or Pricing Data. The definition of cost or pricing data consists of three basic elements: (1) *facts* (but not judgments), (2) *significant effect* on price negotiations, and (3) existing at the *date of agreement* on price. (Morrison and Ebert, 1989:6) Contractors, contracting officers, the Armed Services Board of Contract Appeals (ASBCA) and the courts continue to struggle with interpreting these seemingly simple terms.

(1) Facts (but not Judgments). In defining cost or pricing data, the statute states explicitly that cost or pricing data, "...does not include information that is judgmental, but does include the factual information from which a judgment was derived" (10 U.S.C. §2306a). The distinction between fact and judgment is based on the premise that facts can be verified and judgments cannot. In Lambert Engineering Co., ASBCA No. 13338, 69-1 BCA, the board held that verifiable labor hour estimates derived from historical data are cost or pricing data (Boyd, 1993:47). In contrast, the board held in E-Systems, Inc., ASBCA No. 17557, 74-2 BCA 10,782, aff'd on recon, 74-2 BCA 943, that the profit plan dealing with prospects for future business and the resulting effect of overhead was speculative in nature and not cost or pricing data (IG, 1993:6-15).

Management decisions based on judgmental information must be disclosed, however, even if the decision has not been implemented (JAG School, 1992:21). Despite board decisions, the determination whether a judgment, projection, or estimate is defined as cost or pricing data is a question of fact that must be determined on a case by case basis (Boyd, 1993:48).

(2) Significant Effect on Price Negotiations. The issue of significance is the degree to which "prudent buyers and sellers" would expect the data in question to affect the contract price. Most court cases on this issue involved non-reported vendor quotations. "Cost and pricing data is made up of costs which *may* (emphasis added) or will make up part of the total cost of a contract..." (189 Ct. Cl. at 89-90). The unanswered question is which vendor quotes may become a part of the total cost of the contract? The possibility of selecting a supplier makes that quote cost or pricing data, even if the proposal is not based on the quote or the quote is nonresponsive as initially submitted. But if a quote is so outrageous that a prudent buyer or seller would not consider it, case law has indicated that the quote is not cost or pricing data (Lovitky, Winter 1987:82; Boyd, 1993:55).

(3) Existing at the Date of Agreement on Price. A fact is considered cost or pricing data only if it is significant "as of the date of agreement on the price" (10 U.S.C. §2306(a)(g)). Therefore, facts arising after that date are not cost or pricing data, even if they are available prior to certification or contract award. This determination has been consistently upheld in the courts.

Proof Element 2: Cost or Pricing Data Existed and Were Available. In most cases, if the data existed prior to price agreement, it will be considered reasonably available (Boyd, 1993:127). This is troublesome to contractors because the mere receipt of a vendor quotation within an organization does not mean that it will instantaneously be provided to the contractor's negotiators. Normal processing delays are inevitable

(Lovitky, Summer 1987:63). An exception to the general rule of assumed availability occurs when government urgency does not allow the contractor time to update its cost or pricing data (LTV Electrosystems, Inc., ASBCA No. 16802, 73-BCA ¶ 9957, aff'd on recon denied, 74-1 BCA ¶ 10,380).

Proof Element 3: Cost or Pricing Data Were Not Submitted. While TINA and its implementing regulations are explicit about the requirement to submit cost or pricing data, very little guidance is provided on the specifics of that submission. What is clear is that the data must be submitted to the cognizant contracting officer or a designated representative of the contracting officer. In addition, making corporate records available for government inspection is not sufficient. Instead, disclosure must be made by physical delivery of the data or by specific identification (McDonnell Douglas Corporation, ASBCA No. 12786, 69-2 BCA 7897 (1969)).

Other areas of submission requirements are less clear. The statutory requirement is to submit and certify cost or pricing data and neither the act nor the regulations require the contractor to create, collect, arrange, evaluate, or review cost or pricing data (Doke, 1989:24). In American Machine & Foundry, the Board held that contractors should not have to "lead the government by the hand, forcing it to analyze relevant data, properly submitted, but which the Government chooses or happens to ignore" (American Machine & Foundry Co., ASBCA No. 15037, 74-1 BCA ¶ 10,409). In another case, the court held that the contractor must explain the significance of the data if it is not clear to the Government pricing personnel (Sylvania Electric Products, Inc. v. U.S. 202 Ct. Cl. 16, 479 F2d 1342 (1973)). While the case law is inconsistent, it does appear that raw data is often insufficient. Instead, the data must be organized and indexed to give it meaning and relevance (Lovitky, Summer 1987:62).

Proof Element 4: Government Relied on Defective Data. The government's burden of proof for this element has been substantially reduced by regulation and Board decisions

(Boyd, 1993:127-128). The appeal of American Bosch Arma Corp., ASBCA 10,305, 65-2 BCA 5280, created a refutable presumption that, with no evidence to the contrary, the defective data caused dollar-for-dollar "natural and probable consequences." To cause these "natural and probable consequences," it must be assumed that the data were relied upon. This presumption effectively shifts the burden of proof to the contractor who may rebut by proving that the data were, in fact, not relied upon.

Proof Element 5: Reliance on Defective Data Caused an Increase in Contract Price. Logically, if the omitted data did not affect the contract price, the government should not be entitled to a price reduction. As in the issue of reliance, the need for the government to prove that the defective data caused an increase in price has been all but eliminated by the refutable presumption of "natural and probable consequences." Therefore, the issues of reliance and causation have essentially been merged and once the submission of defective data is established, the contract price will be reduced unless the contractor can rebut that presumption.

Phase 2: Quantifying the Defect Amount.

After the government proves that defective pricing has, in fact, occurred (Phase 1), the case must be negotiated to determine the amount by which the contract price shall be reduced (Phase 2). According to Rudland and Lovitky, the difficulty in quantifying the price reduction arises from having to determine (1) how the defective data influenced the final negotiated agreement and (2) what would have been negotiated if the correct data had been disclosed (1992:5; 1988:429). The problem associated with the first determination is that, "where a lump-sum, final contract price has been reached following total price offers and counteroffers, there is little way of knowing what the negotiators agreed to with respect to the cost element in question, much less how the defective cost data influenced the lump-sum price" (Rudland, 1992:6). The dollar-for-dollar method, where the contract price is adjusted downward by the exact amount of the defect, is the

least speculative, easiest to apply, and generally the most accepted (Lovitky, 1988:427). The second determination--what the negotiators would have done, had the appropriate cost or pricing data been disclosed--is even more speculative and virtually impossible to conclude. The boards have contrived a variety of solutions, ranging from acceptance of the government's position of what would have happened (if deemed reasonable), to construction of agreements which in all likelihood would not have been struck by the parties (Rudland, 1992:12).

A contractor can reduce its liability for defective pricing by demonstrating entitlement to an offset. This means that defective data which overstated the contract price can be offset by data which understated the price. The offset must arise out of the same pricing action as the government's claim for defective pricing and must not have been intentionally inserted in the original price agreement by the contractor. The government's defenses to the proposed offset are the same as the contractor's defenses for the defective pricing allegation (Morrison and Ebert, 1989:14).

D'..position Process

In discussing the law governing defective pricing, the elements required to substantiate an allegation and quantification of the defects, the necessary groundwork to understand defective pricing has been laid. This section describes the process used by DoD to detect and resolve defective pricing cases.

Detection. Defective pricing is usually discovered during a postaward audit by DCAA and to a lesser extent, the DoD IG and GAO. During these audits, the records and data available to the contractor, as of the date of price agreement, are analyzed and compared with the previously disclosed cost or pricing data. The auditor investigates the five proof elements discussed earlier to determine whether defective pricing has occurred.

Only a limited number of pricing actions are selected by DCAA for these postaward audits. The selection is determined by two factors: an annual assessment of the risk that

major contractors pose for defective pricing and the dollar amount of the contract action. The selection plan initiated in fiscal year 1992 evaluates the contractor on four factors: (1) Estimating System Deficiencies; (2) Accounting System Deficiencies; (3) Incidence of Defective Pricing; and (4) Amount of Recommended Price Adjustments. If a contractor is evaluated as high risk, DCAA audits all negotiated fixed price contracts worth $10 - $25 million (US GAO, Jun 1992:3). The overall effect of this evaluation shows that a relatively small number of contractors each year account for approximately 80% of the defective pricing (US GAO, May 1992:2).

Resolution. When an audit report alleging defective pricing is completed, DCAA sends it to the cognizant contracting agency. Department of Defense Directive 7640.2, "Policy for Follow-up on Contract Audit Reports," provides the contract agency procedural guidance for the disposition of audit reports. The following is an outline of the steps required to resolve a defective pricing case (IG, 1993:2-1 to 2-4):

1. Contracting Officer (CO) receives the initial audit report and ensures information is entered into the audit follow-up tracking system.

2. CO reviews the report. In virtually all of the complex cases, DCAA will have discussed the findings with the CO while the audit was in draft form.

3. CO sends a copy of the audit report to the contractor and requests a written response. In most cases, DCAA has already provided the contractor with the specifics during its audit.

4. CO receives contractor response and allows DCAA to comment. DCAA may or may not issue supplemental audit reports changing the recommended price adjustment (RPA) based on contractor and contracting officer comments.

5. CO establishes prenegotiation objective after reviewing comments.

6. CO conducts negotiations with the contractor and reaches an agreement.

7. CO prepares necessary support documentation, such as the Price Negotiation Memorandum (PNM) and contract modification.

8. CO obtains clearance reviews, including legal review if required.

9. CO obtains contractor signature on contract modification (if bilateral), distributes the modification, and ensures that proper debt collection procedures are performed.

Critical Policy Issues

As evidenced from the discussions above, there are many legal and quantification problems that must be resolved and administrative steps to be accomplished prior to case disposition. There are also several critical policy issues which must be considered during the disposition process. These policy issues are critical because they directly impact the implementation and effectiveness of TINA and the ability of contracting officers to successfully resolve defective pricing cases.

Distinction Between Defective Pricing and Fraud. An important misunderstanding is the distinction between defective pricing and fraud. Defective pricing cases typically deal with technical interpretations of the submission requirements. For these cases, the contractor has submitted substantial data, but inadvertently omits a particular document. In contrast, fraud cases usually involve either falsification of data or a scheme (e.g., patterns of systematic defects) to obtain higher prices (Nash and Cibinic, Dec 1990:180-181).

Despite rather clear guidelines of what constitutes fraud by the courts and boards, there is a perception, especially among contractors, that all defective pricing cases are referred for fraud investigation. This perception has been fueled by the Inspector General recommendation that all defective pricing should be referred for criminal investigation. (Nash and Cibinic, Sep 1990:129). Contrary to contractor perceptions, the vast majority of defective pricing cases were not referred for criminal investigation. In fact, only 0.5%

(16) of the defective pricing cases in fiscal year 1992 were referred to the Defense Criminal Investigative Services (IG, 1993:1-3).

Given the financial and technical complexities involved in pricing a government contract, the potential for inadvertent defective pricing is always present (Shirk and Greenberg, 1984:322). Referring all defective pricing cases for fraud investigation mixes together the intentional and unintentional violations. This mixing imposes absurd litigation and financial risks on the inadvertent offender and substantially increases the government's disposition times (Joseph and others, 1990:151).

Subcontracts. Another critical issue is the significant amount of defective pricing currently being discovered in subcontracts. In the three year period ended 1990, 63% of all defective pricing cases involved subcontracts (US GAO/NSIAD-92-131, May 1992:5). The amount of defective pricing, as a percentage of contract value, was highest in smaller dollar subcontracts (US GAO, Mar 1991:8).

Additional concern in the subcontract area arises from DCAA's limited audit coverage of subcontractor proposals. This limitation is due primarily to the lack of a complete and accurate account of all subcontracts. In its 1992 review of four major DoD prime contracts, valued at $1.1 billion, GAO found that DCAA was not aware of 186 of the 211 related subcontracts. Those 186 subcontracts had a total value of $189 million (US GAO/NSIAD-92-173, May 1992:2). In addition to the obvious inability to audit subcontracts it is not aware of, DCAA performs almost no audits of low dollar value subcontracts. As such, the already appalling finding that 63% of the defective pricing cases are related to subcontracts may actually be a gross understatement of what is truly occurring.

Sweep Data. A current issue is the growing use of contractor sweeps to collect cost or pricing data. A data sweep is an update of all cost or pricing data that is submitted after agreement on price, but prior to the submission of the Certificate of Current Cost or

Pricing Data. Although certificates are required from the contractor as soon as practicable after price agreement is reached, sluggish submissions, some in excess of 30 days, have delayed execution of agreements and undermined the intent of the law. Contractors contend that these extensive sweeps are necessary to ensure that all submitted cost or pricing data were current, accurate, and complete.

On 7 June 1989, the Deputy Assistant Secretary of Defense for Procurement issued a policy letter instructing the contracting officer to "require the contractor to provide an impact statement summarizing the impact of the additional data" provided as the result of a sweep (OASD Ltr). This policy is controversial because there is no provision for such impact statements in the law or regulations. An additional problem with sweep data is the government's direction to reduce the agreed upon price if it was inflated because of the failure to submit the sweep data before price agreement; no such allowance is made for upward adjustment (IG, 1993:3-5). Nash and Cibinic have challenged these instructions, arguing that "whether sweep data should be used to decrease or increase the agreed upon price is a matter for negotiation and is not a subject for unilateral CO determination" (1993:84).

Interest Payments and Penalty Provisions. Congress added an interest provision to TINA because, under the original legislation, contractors had little incentive to expedite settlements on defective pricing cases. The effectiveness of this new incentive tool is questionable, however, because DoD has not fully utilized the provision. Contracting officers, acting without specific authority, have not always charged the full amount, if any, of the interest due on overpayments (US GAO, 1993:20).

A penalty provision, which doubles the amount owed by the contractor, was also added. The penalty is imposed when defective data are knowingly submitted, thus recognizing the distinction between intentional and unintentional defective pricing. Under the original provision, the chance of having to pay back a deliberate overpricing amount,

albeit with interest, is not very risky, and may not be an effective deterrent for the intentional offender. This provision was designed to solve that problem, while not imposing undue hardship on unintentional defective pricers. As with the interest provision, however, the penalty provision has not been well implemented. The regulations provide no assistance on assessing the penalty, and DoD officials know of no instances where the penalty has been assessed.

Factors Suggested by Oversight Organizations

The impact of legislative and policy issues, as well as the cumbersome process to detect and resolve a defective pricing case, have taken a toll on the government's ability to recoup the auditor's recommended price adjustment and settle cases within the one year guideline. Additional factors contributing to low sustention rates and lengthy disposition times have been identified by GAO and DoD IG through their investigations and are discussed below.

Low Sustention Rates. For defective pricing cases settled in fiscal year 1992, DoD reported that 40% of the $239 million in recommended price adjustments was sustained. This latest rate reflects a drop of 9% over the previous five years (US GAO, 1993:12). The GAO identified the following causes of poor sustention rates (US GAO, 1993:13-18):

1. Audit report had errors or contained facts that were inconclusive.

2. Government had insufficient evidence to counter contractor's claim regarding data availability due to deficiencies in record keeping and government Price Negotiation Memoranda (PNM).

3. Contracting officers did not rely on the defective data.

4. Inappropriate contracting officer determinations reduced or eliminated the price adjustments.

5. Negotiations reduced the price adjustment to avoid administrative costs and litigation.

6. Contracting officers accepted contractor offsets, even though DCAA did not consider them valid.

The IG identified the following reasons for low sustention rates (IG, 1990:11-13):

1. Contracting officers said that they did not rely on defective data when negotiating the contract price.

2. Contracting officers accepted data provided by contractors during negotiations.

3. Contract audit reports contained inaccurate or outdated information.

4. Legal counsel advised against sustention because the audit issues were not supportable.

5. Contracting officers disagreed with the auditor's position.

6. Contracting officers agreed to bottom-line settlements because agreement on individual cost elements could not be reached with contractors.

7. The sustained amount was part of a global settlement.

8. Contractor appealed and court or board decided issues in favor of the contractor.

9. Contracting officers considered the amount not sustained immaterial.

10. Events after the audit report was issued, such as finalization of rates, changed the advisability of sustention.

The IG provided two recommendations to improve sustention rates. The first was to adhere to required review and clearance procedures to ensure that contracting officer determinations are fully supported. The second, to analyze settlement data to identify major factors affecting sustention performance. On the basis of the DoD IG recommendations, this research identifies and analyzes factors which affect sustention rates (IG, 1990:15).

Lengthy Disposition Times. Because the government has the burden of proof in establishing each of the five elements for defective pricing, DoD's disposition process is inherently lengthy. During settlement, DoD is responsible for proving the five basic

elements and defending the amount to be recovered. In response, contractors must provide data to support their cost proposal, develop a point-by-point rebuttal to the auditor's findings, and negotiate or appeal the final settlement. Based on the multiple steps that need to be accomplished to complete a case, DoD settles only half of its cases within the one year guideline (US GAO, 1993:27). Other than the cumbersome process, lack of experience, expertise, priority, effective monitoring controls, and management attention are the only other major factors identified in the literature for lengthy disposition times of defective pricing cases (IG Ltr, 1993).

Past Research

With the exception of case law analysis and DoD IG and GAO investigations, little research has been done in defective pricing. This section summarizes what has been done.

In 1984, Brown and Ellis analyzed the procedures being used by the Air Force Systems and Logistics Commands to resolve defective pricing cases and developed management tools to assist in the timely and effective disposition of these cases. Their analysis revealed that the standard to resolve defective pricing cases was inadequate and recommended an additional 45 days. They also recommended the establishment of a single defective pricing OPR, incentives, such as interest charges, to motivate timely contractor response, increased managerial emphasis, and adoption of expanded defective pricing milestones (Brown and Ellis, 1984:Ch 5).

In her 1988 master's thesis, Volpe demonstrated that pursuing defective pricing allegations below $50,000 costs the government more in manpower than the funds recouped from the contractor. Therefore, Volpe recommended that defective pricing cases under $50,000 be pursued only on a limited basis. This limited enforcement would balance cost effectiveness with the need for an effective deterrent to defective pricing, regardless of dollar value. An ancillary finding of this research was that the time it took to process a case was not related to the allegation amount. Instead, she found a

correlation between processing time and the contract value of the action audited--the greater the value, the longer it took to settle the case (Volpe, 1988:Ch 5).

Identification of Factors from Literature Review

Based on the literature review above, discussions with defective pricing experts, and personal experience, the researchers compiled a set of factors for both sustention rates and disposition times. Although suggested factors were generally specified for either times or rates, the researchers used the factors for both times and rates, when appropriate. This set of factors, along with a brief definition, description of the effect on rates and times, and reference to the source which identified the factor is summarized in Table 1.

TABLE 1

SUMMARY OF SUGGESTED FACTORS FOR SUSTENTION RATES AND DISPOSITION TIMES

Factor	Definition	Affect on Rates & Times	Source
Alleged Defect Amount	The auditor's Recommend Price Adjustment (RPA)	Larger amounts ⇓ rates, ⇑ times	Volpe's thesis
Ratio of RPA to Audited Amount	Proportion of the defect amount to total audited contract action	Increased ratios ⇓ rates, ⇑ times	Variation from Volpe's thesis
Cost Element	Identifies which cost element the defective data pertained to: labor, material, indirect or other	Material & labor ⇑ rates, ⇓ times as compared to indirect costs	J.A. Lovitky, Nat'l Contract Mgt Journal, Winter 1987
Contractor Level	Identifies which party, the prime contractor or subcontractor, committed the defective pricing.	Subcontractor Unknown for rates, ⇑ times	GAO/NSIAD -92-131
Type of Contract Action	Indicates whether defective pricing occurred on an original contract or contract modification	Original contracts ⇓ rates, ⇑ times	Defective pricing expert

TABLE 1 (CONT'D)

CO Disagreement with RPA	Indicates whether the contracting officer disagreed with the RPA	Disagreement w/RPA ⇓ rates, ⇑ times	IG Report # AFU91-1
Number of Issues	Number of separate issues involved in a single defective pricing case	More issues ⇓ rates, ⇑ times	Defective pricing expert
Complexity	Indicates the complexity of the legal issues surrounding the case	More Complex ⇓ rates, ⇑ times	GAO/NSIAD -94-7
Offsets	Indicates whether or not the contractor proposed offsets	Proposed offsets Unknown on rates, ⇑ times	GAO/NSIAD -94-7
Recipient of Funds	Indicates whether the program office or the General Treasury received the recovered funds	Program office ⇑ rates, ⇓ times	Defective Pricing Expert
Method of Disposition	Indicates how the case was settled: negotiation, out-of-court settlement, or litigation.	Litigation ⇓ rates, ⇑ times	IG Report # AFU91-1
Fraud Investigation	Indicates whether or not the case was investigated for fraud.	Fraud investigation ⇑ rates, ⇑ times	GAO/NSIAD -94-7
Up-Front Time	Number of days between the initial audit and last supplement, if any	Greater # of days ⇑ rates, ⇑ times	GAO/NSIAD -94-7
Disposition Time	Number of days between initial audit and modification issuance	Longer times ⇓ rates, N/A for times	AFMC audit follow-up statistics
Contract Type	Indicates whether the case involves a fixed price or cost reimbursement contract	Fixed-price ⇓ rates, ⇑ times	Nash & Cibinic Report Jan 1991
Contract Action Audit Amount	The total dollar value of the audited contract action	Larger amounts, ⇓ rates, ⇑ times	Volpe's Thesis
Contractor Size	Categorizes the contractor as a large or small business	Unknown effect on rates and times	Researchers
Contract Cost Performance	Indicates whether the contract is in an overrun or underrun state	Overrun ⇓ rates, ⇑ times	Researchers

TABLE 1 (CONT'D)

Identity of Prime Contractor	Identifies the prime contractor involved in the case	Contractors differ in rates and times	GAO/NSIAD -92-183
Gov't Negotiator Expertise	Number of cases the government negotiator had previously resolved	More cases ⇑ rates, ⇓ times	Senate IG Testimony, 4 Jun 92
Contractor Negotiator Expertise	Number of cases the contractor negotiator had previously resolved	More cases ⇓ rates, unknown effect on times	Variation from Senate IG Testimony
Organizational Structure	Indicates whether the contracting activity which resolved the case was centralized or decentralized	Centralized ⇑ rates, ⇓ times	Senate IG Testimony, 4 Jun 92
Workload	Captures the workload level of the gov't negotiator at the time the case is being resolved	Higher workload ⇓ rates, ⇑ times	Researchers
Priority	Identifies the priority given to cases relative to other actions	Lower priority ⇓ rates, ⇑ times	9/93 IG audit review at San Antonio

Summary

This chapter examined the current interpretative issues being addressed in the courts and boards, discussed procedural aspects of the disposition of a defective pricing case, highlighted current policy issues, and examined the impact that these issues have on sustention rates and disposition times. Based on this literature review, a list of factors affecting sustention rates and disposition times was generated.

Chapter 3 describes the interview process used to validate the list of factors generated by the literature review, the analysis of variance procedures that determined which factors contributed significantly to explaining sustention rates and disposition times, and the statistical techniques employed in model development and validation.

III. METHODOLOGY

Overview

This chapter describes the three methods used to achieve the research objectives. The first two objectives were to identify factors that affect sustention rates and disposition times. These objectives were accomplished by reviewing applicable literature and surveying defective pricing experts through personal and telephone interviews. The third objective was to determine which of the factors explain the greatest variation in sustention rates and disposition times. This was accomplished through one-way analysis of variance and multiple comparison of means tests. The last two objectives were to develop and validate two models using the statistically significant factors--one to explain sustention rates and the other, disposition times. These objectives were met using multiple linear regression (MLR).

Identification of Factors from Interviews

Method Selection. On the basis of a literature review, personal experience, and discussions with defective pricing experts at Aeronautical Systems Center, a list of potential factors affecting sustention rates and disposition times was compiled. This list of initial factors was presented in Chapter 2, Table 1. To validate this initial set of factors and identify important additional factors, it was necessary to survey defective pricing experts. The goal was to ensure that all variables affecting sustention rates and disposition times were identified. To accomplish this goal, personal interviews and telephone interviews were conducted. Interviews were selected for two reasons:

(1) Based on the inherent complexity of defective pricing issues, it was considered essential that a two-way dialogue take place. It was important that the interviewers be

able to answer questions about the survey, secure an in-depth and detailed response, and probe for additional information on potential factors (Emory and Cooper, 1991:338).

(2) Because of the relatively few number of defective pricing experts (24), there were sufficient time and resources to interview them either in person or by telephone. Individuals in the local area were interviewed in person; those outside the area were interviewed by telephone.

Survey Development. The twenty-four factors identified in Table 1 were incorporated into a series of closed response questions. The purpose of these questions was to have the respondents identify which of the given factors they presumed affected sustention rates and resolution times, and to what extent. The extent to which each factor affected rates and times was measured on a 5-point Likert scale. The scale ranged from no effect (1) to very strong effect (5). After the series of closed response questions, the survey concluded with open response questions. These questions allowed the respondent to provide any additional factors that they presumed affected sustention rates and/or resolution times, and the degree of impact. The purpose of the open-ended questions was to ensure that no worthwhile factors were erroneously omitted. The omission of such factors would have seriously diminished the researchers' ability to develop useful models.

To ensure the interview questions were clear and understandable, the draft survey was reviewed by two AFIT faculty members and three defective pricing experts at ASC. Their comments were incorporated into the final version. The survey is included as Appendix A.

Participant Selection. The selection process was designed to incorporate the different perspectives of those involved in the resolution and oversight of defective pricing cases. The varying perspectives are gained by working in one of three types of organizations: line, staff, or oversight.

Line members, such as contracting officers and negotiators/pricers who had recent experience resolving defective pricing cases, were interviewed. The defective pricing focal points at each of the three product centers identified the line members they considered to be their defective pricing experts. Each suggested expert was then contacted to confirm whether they had sufficient knowledge and/or experience to competently answer the survey questions. Those interviewed in ASC's centralized defective pricing organization had between one and five years of experience resolving defective pricing cases, with ten to twenty cases being resolved per year. Those interviewed in SMC's and ESC's decentralized organizations resolved between three and seven cases in the last three years.

Insight into the staff perspective was gained by interviewing the center's defective pricing focal points, DCAA liaison auditors, legal advisors, and Headquarters AFMC and DCAA personnel. Defective pricing focal points disseminate applicable policy, assist line members, monitor and report resolution of defective pricing cases, and resolve selected cases, when necessary. The DCAA liaison auditors act as liaisons between the DCAA and contracting personnel at the centers on all audit matters, including defective pricing. Two lawyers at the Air Force Materiel Command Law Center, who provide primary legal support for the resolution of defective pricing cases for AFMC, were interviewed. They have over thirty years of combined defective pricing experience. The HQ staff participants also had extensive and varied backgrounds relating to defective pricing.

To incorporate the broad experience and perspective of an oversight organization, individuals from the DoD IG were interviewed. The interviewees had reviewed hundreds of Army, Navy, Air Force, and Defense Logistics Agency (DLA) defective pricing cases.

From the various line, staff, and oversight organizations, a total of twenty-four interviews were conducted. The list of interviewees is included as Appendix B.

Interview Technique. An advance copy of the survey was sent to all interview participants to allow for adequate preparation. The interviews were conducted with both

researchers present. To minimize disruption and possible confusion during the interview, especially those over the telephone, the survey questions were asked by only one researcher. Each researcher took separate notes during the interview and a comparison was made immediately after each interview.

After ensuring consistency in recording all respondents' comments and scoring, the median was calculated for the aggregate factors. Factors with a median of 3 (moderate effect) or greater were considered to be significant and validated by the interviews. The median was chosen as the best discriminator because it suggests that at least half of the respondents judged the effect to be moderate or greater.

Data Collection

All of the factors deemed to be significant during the interviews were screened for inclusion in analysis of variance and model building. To decrease the subjectivity of classification by the researchers and ensure usefulness of the resulting models, only those factors for which data could easily be collected were further analyzed. Data on sustention rates, disposition times, and the selected independent variables were obtained from two sources: the PK Audit Reporting System (PARS) and contract files.

PK Audit Reporting System (PARS). PARS is an audit tracking system hosted on the Automated Management Information System (AMIS) mainframe. AFMC's Contracting Automation and Data Systems Division queried the system and provided a list of all defective pricing cases closed between 1 March 1991 and 31 March 1994. For each case, the audit report number and date, contractor, contracting center, cost questioned, cost sustained, litigation number, resolution date, resolution age, disposition date, and disposition age were collected. Appendix C contains a complete listing of the PARS data sheets used for this research.

PARS information was entered into the system by the defective pricing focal point at the centers. To ensure accuracy, many of the input fields include edit checks to prevent

entry of an incorrect value. Despite this precaution, both the GAO and DoD IG have found numerous reporting errors in costs questioned and amounts sustained (US GAO, 1993:29). As such, the original contract files containing the defective pricing information were used to verify or correct the data received from PARS, as well as supplement data not included in the PARS system.

Contract Files. The contracting centers' contract files were reviewed for pertinent facts and figures on the factors being investigated. Among the documentation analyzed were audit reports, price negotiation memoranda, contract modifications, legal opinions, and contractor response letters. While not all the contract files contained all the documentation, there was sufficient information in the majority of the files to determine what had transpired. When discrepancies were found between PARS and the contract file documentation, the data in the contract files were deemed more reliable and used.

The contract file is prepared and maintained by the contract negotiator, in accordance with applicable procedures. The file documentation is generally reviewed for accuracy and completeness by the contracting officer and legal counsel, and, if the dollar amount is large enough, by a contracting committee. These internal reviews increased the researchers' confidence in the data's validity and reliability.

Data Selection. This research attempted to analyze all defective pricing cases resolved by AFMC product centers between 1 March 1991 and 31 March 1994. The three centers for which data were gathered were Aeronautical Systems Center (ASC) at Wright-Patterson AFB, Space and Missile Systems Center (SMC) at Los Angeles AFB, and Electronic Systems Center (ESC) at Hanscom AFB. The fourth product center, Human Systems Center (HSC), was not selected because, according to PARS, HSC did not settle any defective pricing cases during the specified time period. AFMC's logistics centers were also eliminated because of the difficulty in obtaining reliable defective pricing data. This difficulty stems from the recent Air Force Logistics Command (AFLC)/Air

Force Systems Command (AFSC) merger in July 1992. HQ AFSC had a central, automated system prior to the merger; HQ AFLC did not. AFLC's data were described by HQ AFMC's defective pricing focal point as incomplete and inaccurate prior to and six months after the 1992 merger. To ensure data integrity and consistency, this research analyzed defective pricing cases from the AFMC product centers only.

Data were collected on all defective pricing cases contained in PARS for the three product centers. Defective pricing data were input into PARS beginning March 1991. As such, all defective pricing cases closed between 1 March 1991 and 31 March 1994 at ASC, SMC, and ESC were considered for this research.

It was necessary to eliminate certain defective pricing cases during the 1991-1994 time frame. Cases which had a reported sustention amount of $0 were eliminated. These were cases in which the contracting activity determined that defective pricing had not occurred. Because the contracting activity has the ultimate authority in determining whether defective pricing occurred, those cases with a zero sustention rate were removed from consideration. The contract files for an additional 17 cases could not be located. The PARS data for these missing cases were analyzed and no commonalities were identified. As such, it was concluded that the missing files occurred at random so their absence does not affect the research results. With these exclusions, data were collected on a total of 118 cases. The frequency distribution of cases for each center was as follows: ASC 72%, SMC 16%, and ESC 12%.

Analysis of Variance

Analysis of variance (ANOVA) is used to study the effects of one or more independent variables on a dependent variable. In this research, ANOVA techniques were used to determine which of the factors validated during the interview process explain the greatest variation in sustention rates and disposition times. The SAS statistical software package was used to perform the analyses. SAS includes two procedures for analysis of

variance - ANOVA and General Linear Model (GLM). The ANOVA procedure is limited to situations involving equal cell sizes. Because this research involved observational data that resulted in unequal cell sizes, the GLM approach was employed.

ANOVA Models. One-way ANOVAs were conducted for each of the variables validated during the interview process to determine the variables' effects on sustention rates and disposition times. The model used for these tests was:

$$Y_{ij} = \mu. + X_i + \varepsilon_{ij}$$

where Y is the response or dependent variable (sustention rate or disposition time);

X_i are the factor levels of the independent variables;

$i = 1,..., m$;

m = number of levels for the independent variables;

$j = 1,..., n$; and

n = number of observations.

The model results were used for hypothesis testing and the coefficient of determination was evaluated to assess the extent to which each factor explains the variation in sustention rates and disposition times.

Hypothesis Testing. The F test was used for hypothesis testing. The F test is a preliminary test which determines if there is a statistically significant difference between any of the factor level means. The hypotheses tested in the ANOVAs were:

H_o: All factor level means are equal.

H_a: At least two of the factor level means are not equal.

If the F test provided no evidence of differences between the factor level means at the $\alpha = .05$ level, it was concluded that no relationship exists between the factor and the dependent variable. If the F test indicated that the factor level means differ from one another and there were only two factor levels, no additional analysis was required; if there were more than two factor levels, additional analysis was required to determine the nature

of the factor level effects. In these cases, the Bonferroni method of multiple comparisons was used to determine which of the factor level means differ from one another. The Bonferroni method was selected because of its applicability to situations involving unequal cell sizes (Neter and others, 1985:582). The Bonferroni tests examined pairwise comparisons of the factor level means at the $\alpha = .05$ level.

Coefficient of Determination. The coefficient of determination, or R^2, is the ratio of explained variance to total variance and measures how well a linear model fits a set of data. The value of R^2 is always between 0 and 1, where $R^2 = 0$ implies a complete lack of fit of the model to the data and $R^2 = 1$ implies a perfect fit, with the model passing through every data point. The R^2 of each ANOVA model was reviewed to assess the amount of variation in the dependent variable that was explained by the single independent variable.

Assumptions. In an analysis of variance model, it is assumed that (Neter and others, 1985:524):

(1) Each of the probability distributions is normal.

(2) Each probability distribution has the same variance.

(3) The observations for each factor level are random and independent.

Wilk-Shapiro rankit plots revealed that the distributions of the dependent variables were not normal. However, the F-test used in ANOVA is robust against departures from normality. As such, the F-test can still be used with little effect on the level of significance or power of the test (Neter and others, 1985:624).

The Bartlett test was used to evaluate homogeneity of variance. The Bartlett test is sensitive to nonnormality, however, especially for long-tailed distributions. In such cases, heteroscedasticity is detected too often. Anderson and McClean recommend evaluating the Bartlett test at the $\alpha = .001$ level in these circumstances (1974:19). The distributions of both disposition times and sustention rates are nonnormal with long tails and several of

the populations were found to violate the assumption of equal variances at the $\alpha = .001$ level.

Heteroscedasticity, or unequal variances, can be corrected through transformation of the dependent variable (Anderson and McLean, 1974:17) or weighted least squares. Attempts at transforming the data through use of ArcSin, logarithmic, and square root functions were unsuccessful. Therefore, the weighted least squares approach was used with a weighting of 1 over the variance squared (σ^2). Use of this weighting serves to equalize all variances, thereby satisfying the assumption necessary to ensure validity of the statistical tests (Neter and others, 1985:262).

In this research, all of the defective pricing cases resolved in a three-year time-frame were analyzed. Given the nature of the data, it is presumed that the third assumption, that observations for each factor level are random and independent, is met.

Model Building

Having identified a set of factors for sustention rates and disposition times through the interview process, the factors were further screened through analysis of variance. The factors having means significantly different from one another at the 95% confidence level became the initial set of independent variables considered for model inclusion. Data on the variables were entered in *Statistix 4.0*, a statistical computer program designed to perform multiple linear regression.

Multiple Linear Regression (MLR). The goal of MLR is to build a model, using the best subset of independent variables, to predict values of the dependent variable. The MLR models for sustention rates and disposition times will be in the following format:

$$Y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + ... + \beta_k x_k + \varepsilon$$

where Y is the response or dependent variable;

$x_1, x_2, ..., x_k$ are predictor or independent variables;

$\beta_0, \beta_1, \ldots, \beta_k$ are unknown model parameters called regression coefficients;

k is the number of independent variables included in the model; and

ε is the random error term.

The following four steps were taken to build the MLR models: Step 1, best subset selection; Step 2, verification of model assumptions; Step 3, model determination and evaluation; and Step 4, model validation.

Step 1: Best Subset Selection. For this thesis, the goal is not only predictive accuracy, but also selection of independent variables that facilitate model use. Accomplishing these goals entails: (1) selecting predictor variables for which data are readily available and (2) minimizing the number of predictor variables in the models. The former objective was accomplished through a screening of the interview results prior to data collection, and the latter was achieved through the application of Miller's Method. Miller's Method was chosen, rather than other subset selection techniques, as it guards against bringing random predictors into the model. Research recently conducted by Woollard showed that Miller's Method was the best technique, when compared to Minimum MSE, Minimum Sp, Minimum Cp, for selecting models from a variable pool containing extraneous variables (1993:70).

Miller's method augments the set of predictor variables with an equal number of dummy variables whose values are random numbers. Miller's Method then applies forward stepwise regression and proceeds until the first dummy variable is selected for inclusion in the model. Once this occurs, the regression stops and only those predictor variables selected before the entrance of the dummy variable are considered for inclusion in the model. The rationale, of course, is that any predictor variable selected after a dummy variable must have less significance than that random, dummy variable. Thus, all predictor variables selected after should be discarded as insignificant (Miller, 1984:395).

Miller's Method was implemented in *Statistix 4.0* using the Stepwise Regression program with forward selection. The F-to-enter threshold criteria was set to zero to ensure that all variables, including the random ones, would be admitted into the models. Miller's method was repeated ten times for each model to verify the selection of predictor variables.

Step 2: Verification of Model Assumptions. The assumptions made when conducting a MLR analysis are that the error terms are independent and, for any given set of x values, ε has a normal probability distribution with a mean of zero and constant variance (McClave and Bensen, 1991:526-527). Gross violations of these assumptions may yield an unstable model. The following methods were used to check the validity of these assumptions:

Residual Analysis. Residual analysis involves careful inspection of the differences between the observed and predicted values of the dependent variable after a prediction equation is fit to the data. Residual analysis can detect trends and extreme measurements, such as outliers, and identify assumption violations, such as changes in the error variance (heteroscedasticity) and non-normal error distributions (Gunst and Mason, 1980:220).

Heteroscedasticity. Residual plots were utilized to detect heteroscedasticity. Error variances which are equal over the range of independent variables will show residuals randomly placed above and below the zero line. Deviations from equal variance are portrayed in many forms, such as an expanding cone or football shape of the residual plots. Unequal variances are normally stabilized through a transformation of the dependent variable.

Normal Distribution of Residuals. To check that the random errors are normally distributed with mean of zero, a Wilk-Shapiro/Rankit Plot was accomplished. The straighter the line of rankit plots or the higher the W' Statistic, the more normal the

distribution. For purposes of this research, normality is assumed if the rankit plot appears straight and the W' Statistic exceeds 0.90.

Multicollinearity. Multicollinearity refers to the situation in which some or all of the independent variables are interrelated. When highly correlated independent variables are present in a regression model, the results are often confusing. Indicators of multicollinearity include: a large R^2 value and F-Statistic, but small individual t-values; large changes in the estimated coefficients when a variable is added or deleted; large changes in the coefficients when a data point is altered or dropped; large standard errors for coefficients that are expected to be important; and large variance inflation factors (Chatterjee and Price, 1977:144-156). These indicators of multicollinearity were evaluated using standard regression computations.

Step 3: Model Determination and Evaluation. To test the usefulness of the models, a global test, one that encompasses all β parameters, is required. Statistical measures are also necessary to evaluate how well a linear model fits the data. The methods which were selected and performed are described below.

F-Test. An analysis of variance F-Test is conducted after a multiple linear model is developed and all assumptions are satisfied. The F statistic is the ratio of the explained variance over the unexplained variance. The F-Test indicates whether a significant linear relationship exists between the dependent variable and the combined effects of the independent variables. The Global F-Test is usually regarded as a test that the model must pass to merit further consideration (McClave and Bensen, 1991:543).

Coefficient of Determination. The coefficient of determination, R^2, represents the proportion of the total variability explained by the linear relationship and was used to determine how well the linear models fit the data. R^2 was selected because it is regarded as the natural measure of the uncertainty of predicting the dependent variable. In general, the larger the value of R^2, the better the model predicts the dependent variable.

Step 4: Model Validation. Model validation is an important, but often overlooked, step in model building. Validation is necessary to determine how well the selected models predict using other than fitted data. As such, one third of the original data collected was set aside to validate the predictive capability of the selected models. The non-fitted data were entered into the selected models and a predictive R^2 was calculated for each model. The predictive R^2 for each model was compared with the model's original fitted R^2. The smaller the difference between the predictive R^2 and the fitted R^2, the more robust the model.

Summary

This chapter described the interview process that was used to screen and supplement the initial list of factors presented in Chapter 2. The analysis of variance procedures, which further screened these factors, were also discussed as were the statistical techniques employed in model development and validation. The next chapter presents the research results and the analysis of those results which answer the five investigative questions.

IV. RESULTS

Overview

This chapter describes the results of the research efforts detailed in Chapter 3. The interview results are presented first, followed by the results of data collection, analysis of variance, and model building.

Interview Results

Upon completion of the twenty-four interviews, the medians of the aggregate responses were calculated. If the responses generated a median of 3 (moderate effect) or greater, the factor was considered to be significant and validated by the interviews. The results for each factor are shown in Table 2. Those factors deemed significant were further screened to obtain a subset of factors suitable for analysis of variance. Factors such as negotiator expertise, workload, and priority, were deleted because data were not available. In some cases, this was due to the difficulty in collecting data on a factor and other cases, the inability to determine what type of data should be collected to accurately measure the factor. During the interviews, offsets and the identity of the prime contractor were considered significant by the experts for disposition times but not sustention rates. Because data were collected on those factors, the statistical effect of offsets and the identity of the prime contractor on sustention rates was also assessed.

Three of the original factors, complexity of the issue, up-front time, and disposition time were revised or redefined based on interview discussions. Complexity was renamed legal complexity to indicate the extent to which the issue stretches the limits of legal precedents. This name change was based on confusion over whether "complexity" referred to technical or legal complexity. The consensus of the interviewees was that legal complexity had a stronger effect on the dependent variables than technical complexity. As such, data were collected on the legal complexity of the case, not technical complexity.

To assess legal complexity, legal opinions, documented evaluation of litigation risk, and proposed contractor defenses to the proof elements were reviewed.

The other revisions to the original factors resulted in the combination of up-front time and disposition time into one variable called disposition time, and the creation of a new variable called RPA revisions. When the survey was written, the total time to settle a defective pricing case was broken into two elements: (1) up-front time, which was defined as the time between the initial audit and the last supplement, and (2) disposition time, which was defined in the survey as the time from the last audit supplement to modification distribution. There was confusion over these two factors, and the consensus of those interviewed was that sustention rates are affected by the total time involved in processing a defective pricing case. Therefore, the distinction between the time elements was eliminated. Disposition time was redefined to encompass the entire time from initial audit to contract modification. Up-front time was originally designed to capture the time spent issuing audit supplements and revising the RPA. Because of the confusion and redefinition of disposition time, up-front time was changed to RPA revisions, which captures whether or not the RPA was revised.

In addition to quantifying the effect of the original factors listed on the survey, the interviewees were asked to propose additional factors they believed affected sustention rates or disposition times. Their proposed factors are provided in Table 2. Analysis of the responses led to the addition of one variable which captures whether an interest charge was assessed. Other suggested factors were determined to be partially encompassed in existing variables or did not lend themselves to data collection.

Table 2 summarizes the interview results and the subsequent actions taken by the researchers. The table presents each of the original variables and indicates whether it was deemed significant or insignificant during the interviews. Except where otherwise noted, factors were significant or insignificant for both sustention rates and disposition times.

The median for each factor is also presented as are the additional factors suggested during the interviews. A more in-depth, narrative discussion of these additional factors is contained in Appendix D. For all factors, both original and additional, the action taken by the researchers (factor was deleted, kept, redefined, etc.) is described. Finally, for those factors kept for statistical evaluation, the variable names and measurement categories are provided. A more detailed description of these factors is presented in Appendix E.

TABLE 2

INTERVIEW RESULTS

Survey Number/ Factor	Interview Results: Medians	Action	Variable Name: Measurement Categories
1.1 Alleged Defect Amount	Significant: Rates 3.0/Times 3.0	Kept	RPA: RPA < $200K $200K ≤ RPA < $1M RPA ≥ $1M
1.2 Ratio of RPA to Audited Amount	Insignificant: Rates 2.0/Times 2.0	Deleted	
1.3 Cost Element	Significant: Rates 3.0/Times 3.0	Kept	COSTELEM: Labor, Material, Other, Multiple
1.4 Contractor Level	Significant: Rates 3.0/Times 4.0	Kept	PRIMESUB: Prime or subcontractor defective pricing
1.5 Type of Contract Action	Insignificant: Rates 1.0/Times 1.0	Deleted	
1.6 CO Disagreement with RPA	Significant: Rates 5.0/Times 4.0	Kept	DISAGREE: Prenegotiation Objective < RPA or not
1.7 Number of Issues	Significant: Rates 3.0/Times 4.0	Kept	ISSUES: Single issue or multiple
1.8 Complexity	Significant: Rates 4.0/Times 5.0	Redefined: Legal Complexity	GRAY: Complex legal issues or not
1.9 Offsets	Significant for Times Only: Rates 2.0/Times 3.5	Kept	OFFSETS: No offsets proposed, offsets proposed & accepted by CO, offsets partially accepted, offsets not accepted
1.10 Recipient of Funds	Insignificant: Rates 2.0/Times 2.0	Deleted	
1.11 Method of Disposition	Significant: Rates 4.0/Times 5.0	Kept	METHDISP: Litigated or not
1.12 Fraud Investigation	Significant: Rates 3.5/Times 5.0	Kept	FRAUD: Investigated for fraud or not

TABLE 2 (CONT'D)

1.13 Up-Front Time (defined in survey as the time between initial audit & last supplement)	Significant: Rates 3.0/Times 4.0	Revised: RPA Revisions (# of audit revisions was the key factor of up-front time)	RPA_REVS: RPA revised or not
1.14 Disposition Time (defined in survey as the time between final audit supplement & modification distribution)	Insignificant: Rates 2.0	Redefined as the time between initial audit and modification date	TIME: ≤ 1 year, 1 to 2 years, 2 to 3 years, > 3 years
2.1 Contract Type	Insignificant: Rates 2.0/Times 2.0	Deleted	
2.2 Contract Action Audit Amount	Insignificant: Rates 1.0/Times 1.0	Deleted	
2.3 Contractor Size	Insignificant: Rates 2.0/Times 2.0	Deleted	
2.4 Contract Cost Performance	Insignificant: Rates 2.5/Times 2.0	Deleted	
2.5 Identity of Prime Contractor	Significant for Times Only: Rates 2.5/Times 3.0	Kept	KTR: Boeing, General Dynamics (Fort Worth), Loral, Martin Marietta, McDonnell Douglas, UT/Pratt & Whitney, Other
3.1 Government Negotiator Expertise	Significant: Rates 4.5/Times 4.0	Deleted: data not available	
3.2 Contractor Negotiator Expertise	Significant: Rates 4.0/Times 4.0	Deleted: data not available	
3.3 Organizational Structure	Significant: Rates 4.0/Times 5.0	Redefined: Product Center	CENT: ASC (Centralized), ESC (Decent.), SMC (Decent.)
3.4 Workload (Centralized Offices)	Significant: Rates 3.0/Times 4.0	Deleted: data not available	
3.5 Workload (Decentralized Offices)	Significant: Rates 4.0/Times 5.0	Deleted: data not available	
3.6 Priority (Decentralized Offices)	Significant: Rates 4.0/Times 5.0	Deleted: data not available	
Interest Assessed	Factor suggested in interviews	Added	INTEREST: Interest assessed or not
Audit Characteristics: audit quality/completeness; auditor willingness to revise RPA; cooperation/communication between auditor and CO	Factor suggested in interviews	Not included: partially captured in DISAGREE and RPA_REVS	
Assist Audits: number of subcontractor assist audits in support of a prime contractor audit	Factor suggested in interviews	Not included: partially captured in PRIMESUB and ISSUES	

TABLE 2 (CONT'D)

Contractor Attitudes: willingness to settle, agreement with RPA, networking	Factor suggested in interviews	Not included: partially captured in KTR	
Quality Documentation: completeness/availability of government evidence	Factor suggested in interview	Not included: data not available	
Expertise of Participants: expertise of entire defective pricing team, including CO, legal, auditors, technical personnel, etc.	Factor suggested in interview	Not included: data not available	
Personnel Turnover: turnover of all team members	Factor suggested in interview	Not included: data not available	
Management Attention: mgt attitude, assignment of focal points, training, regular case reporting,	Factor suggest in interview	Not included: data not available, but CENT may provide insight	

Analysis of Variance

Analysis of variance (ANOVA) techniques were used to determine which of the factors for which data were collected explain the greatest variation in sustention rates and disposition times. The one-way analysis of variance results for each factor tested are presented in separate tables. Each table also indicates whether or not there was a significant difference in the class means at the $\alpha = .05$ level. For those factors with significant differences, tables showing the class means and the results of the Bonferroni comparison of means test for rates and times are presented. For the mean comparisons, an asterisk (*) indicates that the means for these classes are significantly different from the means for all other classes at alpha = .05. Means for classes which share the same letter do not differ significantly at alpha = .05.

Alleged Defect Amount (RPA). The results of the one-way analyses using the alleged defect amount as the predictor variable for sustention rate and disposition time are

presented in Table 3. The low p-values indicate that, for both sustention rates and disposition times, the hypothesis that the means are equal for all RPA size categories is rejected at the $\alpha = .05$ level. The R-Squared values indicate that the size of the final RPA alone accounts for over 14% of the total variance in sustention rates and 10% of the variation in disposition times.

TABLE 3

ALLEGED DEFECT AMOUNT - ANOVA RESULTS

Model	DF	F-Value	P-Value	R-Squared	Diff. in μ?
Sustention Rate	2	9.56	.0001	.142606	Yes
Disposition Time	2	6.44	.0022	.100718	Yes

Note: Sustention rate model weighted by $1/\sigma^2$ to equalize variances.

As shown in Table 4, the Bonferroni test revealed that the mean sustention rates differed for each of the size categories. For cases with RPAs of more than $1,000,000, the sustention rates were 32% less than those with smaller RPAs. Similarly, the sustention rates for cases involving between $200,000 and $1,000,000, were less than those involving less than $200,000. Note, however, that while the difference in these last means was determined to be statistically significant, the actual difference is only 0.8%. As such, the distinction between small and medium sized RPAs does not appear to be as important as between small and large sized RPAs. In general, it appears that cases with larger allegation amounts, especially over $1,000,000, will experience lower sustention rates.

For disposition times, the Bonferroni test showed a significant difference in the mean of cases involving less than $200,000 and those involving more than $1,000,000. Cases with an RPA greater than $1,000,000 were found to take an average of 557 days longer than those with smaller RPAs. No statistically significant difference was found

between the other categories, but the average disposition time did increase as the amount of the RPA increased. Therefore, it is concluded that the size of the RPA is a significant predictor of both sustention rates and disposition times.

TABLE 4

ALLEGED DEFECT AMOUNT - MEAN COMPARISONS

Class	# of Observations	Mean Rates & Comparison Test	Mean Times & Comparison Test
<200,000	58	89.4 *	762 a
200,000-1,000000	38	88.6 *	958 a b
≥1,000,000	22	56.6 *	1397 b

* The means for these classes are significantly different from the means for all other classes at alpha = .05.
Means for classes with the same letter do not differ significantly at alpha = .05.

Cost Element (COSTELEM). The results of the one-way analyses using Cost Element as the predictor variable for sustention rate and disposition time are presented in Table 5. The F-values and corresponding p-values show that there are no significant differences in the mean sustention rates or disposition times for the various cost elements. The very low R-squared further indicates that Cost Element does not add to the explanation of either disposition times or sustention rates. Therefore, there is no evidence to support the original hypothesis that the different cost elements introduce varying levels of complexity to defective pricing cases and result in different sustention rates and disposition times.

TABLE 5

COST ELEMENT - ANOVA RESULTS

Model	DF	F-Value	P-Value	R-Squared	Diff. in μ?
Sustention Rate	3	1.8	.1512	.045223	No
Disposition Time	3	.74	.5289	.019165	No

Contractor Level (PRIMESUB). As shown in Table 6, the low p-value for the sustention rate model allows rejection of the hypothesis that the mean sustention rate is the same for prime contractors and subcontractors. While the F test shows a significant difference in the means, however, the R-Squared value of .073915 indicates that this difference accounts for only a small portion of the overall variation in sustention rates. For disposition times, the high p-value and very low R-squared value indicate that disposition times are not affected by the level of the contractor involved.

TABLE 6

CONTRACTOR LEVEL - ANOVA RESULTS

Model	DF	F-Value	P-Value	R-Squared	Diff in μ?
Sustention Rate	1	9.26	.0029	.073915	Yes
Disposition Time	1	.83	.3652	.007074	No

Note: Sustention rate model weighted by $1/\sigma^2$ to equalize variances.

Before conducting this research, the contractor level was believed to impact sustention rates, but the direction of that impact was unknown. Table 7 shows that the sustention rates for cases involving defective pricing at the prime contractor level are an average of 23.8% higher than those involving defective pricing at the subcontractor level. For disposition times, the hypothesis was that subcontractor defective pricing cases would

take longer to resolve than prime contractor cases. This hypothesis was not supported by the data which reflected no significant differences in disposition times.

TABLE 7

CONTRACTOR LEVEL - MEAN COMPARISONS

Class	# of Observations	Mean Rates & Comparison Test	Mean Times & Comparison Test
Prime	93	88.1 *	N/A
Subcontractor	25	64.3 *	

* The means for these classes are significantly different from the means for all other classes at alpha = .05.

CO Disagreement with RPA (DISAGREE). Table 8 shows the results of the one-way analyses using DISAGREE as the predictor variable for sustention rate and disposition time. For sustention rates, the p-value of .0001 indicates a significant difference in the means. In addition, the very high R-squared value, 0.3405, means that this variable is one of the most significant predictors of sustention rates. It is therefore concluded that contracting officer agreement with the audit report, measured by whether or not the negotiation objective matches the final RPA, has a very significant effect on sustention rates.

This DISAGREE variable does not seem as important, however, for disposition times. The high p-value indicates that the means for disposition time do not differ based on agreement with the RPA. The low R-squared value confirms that this variable adds little to the prediction or explanation of disposition times. This indicates that while the contracting officer may recover fewer dollars as a result of the disagreement with the audit report, the case does not take longer to settle. Surprisingly, the expectation that such disagreement would lengthen the disposition times because of the additional time spent attempting to reconcile the government's position was not confirmed.

TABLE 8

CO DISAGREEMENT WITH RPA - ANOVA RESULTS

Model	DF	F-Value	P-Value	R-Squared	Diff. in μ?
Sustention Rate	1	80.76	.0001	.340464	Yes
Disposition Time	1	2.65	.1063	.016655	No

As shown in Table 9, the expectation that CO disagreement with the RPA will lead to lower sustention rates is confirmed by the data. On average, cases involving disagreement lead to a 36.8% lower sustention rate.

TABLE 9

CO DISAGREEMENT WITH RPA - MEAN COMPARISONS

Class	# of Observations	Mean Rates & Comparison Test	Mean Times & Comparison Test
Yes	29	55.3 *	N/A
No	89	92.1 *	

* The means for these classes are significantly different from the means for all other classes at alpha = .05.

Number of Issues (ISSUES). Table 10 displays the ANOVA results for Number of Issues. For sustention rates, the hypothesis that the mean sustention rate is equal whether there were single or multiple issues is rejected at $\alpha = .05$ level. While the difference in means was found to be significant, the low R-Squared value indicates that the number of issues explains only a small portion (6%) of the total variation in sustention rates. As such, the number of issues involved may not be a significant predictor variable. The statistics for disposition times indicate a significant difference in the mean disposition times

between cases with single or multiple issues and that the variable ISSUES does add to the explanation and prediction of disposition times.

TABLE 10

NUMBER OF ISSUES - ANOVA RESULTS

Model	DF	F-Value	P-Value	R-Squared	Diff. in μ?
Sustention Rate	1	7.71	.0064	.062287	Yes
Disposition Time	1	15.77	.0001	.119704	Yes

The mean comparisons in Table 11 confirm the belief that cases involving multiple issues have lower sustention rates and take longer to settle than those with single issues.

TABLE 11

NUMBER OF ISSUES - MEAN COMPARISONS

Class	# of Observations	Mean Rates & Comparison Test	Mean Times & Comparison Test
Single	77	88.0 *	758 *
Multiple	41	73.8 *	1293 *

* The means for these classes are significantly different from the means for all other classes at alpha = .05.

Legal Complexity (GRAY). This variable categorized cases as legally complex or not complex. Determining factors included the presence of opinions commenting on the legal sufficiency of contractor and auditor rebuttals, documented evaluation of litigation risk, strong contractor defenses to the required proof elements, and an overall assessment of the legal difficulties in meeting the burden of proof in each case. The results of the one-way analyses using GRAY as the predictor variable for sustention rate and disposition time are presented in Table 12. The p-values for both models are .0001, indicating great

confidence that mean sustention rates and disposition times vary based on the legal complexity of the issues involved. The high R-squared values indicate that the legal complexity of the case accounts for over 28% of the variation in sustention rates and almost 20% of the variation in disposition times.

TABLE 12

LEGAL COMPLEXITY - ANOVA RESULTS

Model	DF	F-Value	P-Value	R-Squared	Diff. in μ?
Sustention Rate	1	45.86	.0001	.283314	Yes
Disposition Time	1	28.58	.0001	.197653	Yes

Note: Both models weighted by $1/\sigma^2$ to equalize variances.

Table 13 shows that the average sustention rate is much lower and the average disposition time is significantly longer for defective pricing cases involving gray issues. In both cases, the data confirm the original hypotheses.

TABLE 13

LEGAL COMPLEXITY - MEAN COMPARISONS

Class	# of Observations	Mean Rates & Comparison Test	Mean Times & Comparison Test
Complex	45	62.9 *	1398 *
Not Complex	73	95.5 *	664 *

* The means for these classes are significantly different from the means for all other classes at alpha = .05.

Offsets (OFFSETS). The ANOVA results in Table 14 indicate that the hypothesis of equal means can be rejected for sustention rates, but not for disposition times. These results are consistent with the R-squared values which are high for sustention rate and low

for disposition time. As such, the presence of offsets is helpful in explaining and predicting sustention rates, but not disposition times.

TABLE 14

OFFSETS-ANOVA RESULTS

Model	DF	F-Value	P-Value	R-Squared	Diff. in μ?
Sustention Rate	3	12.48	.0001	.247300	Yes
Disposition Time	3	1.75	.1617	.043920	No

Note: Sustention rate model weighted by $1/\sigma^2$ to equalize variances.

The Bonferroni results presented in Table 15 reveal significant differences in the sustention rates for all offset categories. This means that not only is there a difference triggered by the proposal of an offset, there are also differences depending on the contracting officer's evaluation of that offset.

Cases in which offsets are not accepted have the highest sustention rates. Fully accepted offsets have the next highest sustention rates, followed by cases in which no offsets were proposed. The lowest sustention rates were cases in which the offsets were only partially accepted by the contracting officer.

TABLE 15

OFFSETS - MEAN COMPARISONS

Class	# of Observations	Mean Times & Comparison Test	Mean Times & Comparison Test
Not Proposed	76	81.4 *	N/A
Accepted in Full	17	93.9 *	
Accepted in Part	18	73.7 *	
Not Accepted	7	98.9 *	

* The means for these classes are significantly different from the means for all other classes at alpha = .05.

Method of Disposition (METHDISP). Table 16 presents the ANOVA results using METHDISP as the predictor variable for sustention rate and disposition time. For this variable, the F-tests show that at the $\alpha = .05$ level, the average sustention rate and disposition time differ depending on whether or not the case was litigated. The R-squared value of .126631 confirms the importance of the method of disposition in explaining sustention rates. The R-squared value for disposition time is surprisingly low, however, given the large difference in average time shown in Table 17. This anomaly is caused by the fact that only three of the cases analyzed were litigated; it is difficult to perform meaningful statistical analysis with so few data points.

TABLE 16

METHOD OF DISPOSITION - ANOVA RESULTS

Model	DF	F-Value	P-Value	R-Squared	Diff. in μ?
Sustention Rate	1	16.82	.0001	.126631	Yes
Disposition Time	1	9.63	.0024	.076654	Yes

As shown in Table 17, litigated cases take an average of 1295 days longer to resolve than cases settled without litigation. In addition, sustention rates are, on average, almost 75% lower for litigated cases.

TABLE 17

METHOD OF DISPOSITION - MEAN COMPARISONS

Class	# of Observations	Mean Rates & Comparison Test	Mean Times & Comparison Test
Litigated	3	23.3 *	2206 *
Not Litigated	115	84.6 *	911 *

* The means for these classes are significantly different from the means for all other classes at alpha = .05.

Fraud Investigation (FRAUD). As shown in Table 18, the F-values and corresponding p-values indicate that fraud investigations do not lead to statistically different sustention rates or disposition times. The very low R-squared values confirm the fact that FRAUD does not add to the prediction or explanation of either disposition times or sustention rates.

TABLE 18

FRAUD INVESTIGATION - ANOVA RESULTS

Model	DF	F-Value	P-Value	R-Squared	Diff. in μ?
Sustention Rate	1	.04	.8382	.000361	No
Disposition Time	1	2.32	.1305	.019600	No

The analysis of variance conclusions are somewhat surprising given the visibly large difference in the mean disposition times. The results show that cases investigated for fraud took an average of 436 days longer to resolve than those not investigated. Possible explanations for this factor being visibly, but not statistically significant, include the reduced power of the F-test caused by the low number of data points involving fraud investigation (7) and the high standard deviation of that data (670 days).

Disposition Time (TIME). The ANOVA results using Disposition Time as the predictor variable for sustention rate are presented in Table 19. At the $\alpha = .05$ level, the F test indicates that there are differences in the means. The R-squared value indicates that not only are there differences in the means, this variable explains over 10% of the overall variation in sustention rates.

TABLE 19

DISPOSITION TIME - ANOVA RESULTS

Model	DF	F-Value	P-Value	R-Squared	Diff. in μ
Sustention Rate	3	4.45	.0054	.104900	Yes
Disposition Time	N/A	N/A	N/A	N/A	N/A

Note: Sustention rate model weighted by $1/\sigma^2$ to equalize variances.

The Bonferroni test results shown in Table 20 indicate significant differences between all of the time categories, with sustention rate decreasing as disposition time increases. These results confirm the expectation that longer disposition times are associated with lower sustention rates.

TABLE 20

DISPOSITION TIME - MEAN COMPARISONS

Class	# of Observations	Mean Rates & Comparison Test	Mean Times & Comparison Test
< 1 Year	32	94.3 *	N/A
1-2 Years	23	85.8 *	
2-3 Years	24	78.9 *	
>3 Years	39	74.8 *	

* The means for these classes are significantly different from the means for all other classes at alpha = .05.

Identity of the Prime Contractor (KTR). Table 21 displays the one-way ANOVA results for the variable KTR. The p-values of 0.0001 for both models indicate that the mean sustention rate and disposition time for at least one contractor is statistically different than the others. The high R-squared values confirm that Identity of the Prime Contractor is a critical variable in the prediction and explanation of sustention rates.

TABLE 21

IDENTITY OF PRIME CONTRACTOR - ANOVA RESULTS

Model	DF	F-Value	P-Value	R-Squared	Diff. in μ?
Sustention Rate	6	8.62	.0001	.317939	Yes
Disposition Time	6	5.07	.0001	.215014	Yes

Note: Sustention rate model weighted by $1/\sigma^2$ to equalize variances.

To further investigate the differences between contractors, the Bonferroni comparison of means test results are displayed in Table 22. For sustention rates, almost all of the differences among contractors are significant. The exceptions to this are the difference between Loral and Martin Marietta and the difference between United Technologies and Other. Using the data analyzed, the contractors can be listed as follows in ascending order of sustention rates: (1) Boeing; (2) United Technologies/Pratt & Whitney; (3) Other (4) Martin Marietta; (5) Loral; (6) McDonnell-Douglas; and (7) General Dynamics.

For disposition times, the Bonferroni test indicated that significant differences exist for all contractors. Using the data analyzed, the contractors can be listed as follows in ascending order of average disposition time: (1) McDonnell-Douglas; (2) United Technologies/Pratt & Whitney; (3) Boeing; (4) General Dynamics; (5) Loral; and (6) Other (7) Martin Marietta.

TABLE 22

IDENTITY OF PRIME CONTRACTOR - MEAN COMPARISONS

Class	# of Observations	Mean Rates & Comparison Test	Mean Times & Comparison Test
Boeing	11	59.6 a	768 a
General Dynamics	21	102.1 b	860 b
Loral	10	85.2 c	919 c
Martin Marietta	10	84.9 c	1608 d
McDonnell-Douglas	13	88.0 d	418 e
United Tech/P & W	10	77.7 e	761 f
Other	43	78.6 e	1082 g

Note: Means for classes with the same letter do not differ significantly at alpha = .05.

Product Center (CENTER). As shown in Table 23, the F-test for the sustention rate model has a p-value of 0.0121. Therefore, at the $\alpha = .05$ level, the hypothesis that the mean sustention rate is equal for all three centers is rejected. For disposition times, the hypothesis of equal means is also rejected. The R-squared values indicate that Product Center explains 7.4% of the variation in sustention rates and 12% of the variation in disposition times. Therefore, this variable may be a better predictor for disposition times than sustention rates

TABLE 23

PRODUCT CENTER - ANOVA RESULTS

Model	DF	F-Value	P-Value	R-Squared	Diff. in μ?
Sustention Rate	2	4.59	.0121	.073936	Yes
Disposition Time	2	7.84	.0006	.119934	Yes

As shown in Table 24, the Bonferroni comparison of means test revealed that the mean sustention rates for ESC were significantly different than those for ASC. No significant differences were revealed when comparing SMC with ESC and ASC. As with

sustention rates, the Bonferroni test showed a significant difference in the mean disposition times of ASC and ESC, with ESC cases taking longer. No significant differences were found when comparing the disposition times for SMC and ESC or SMC and ASC. These results lead to the conclusion that the product center resolving the defective pricing case does affect both rates and times. On average, ESC cases result in lower sustention rates and longer disposition times than ASC cases.

TABLE 24

PRODUCT CENTER - MEAN COMPARISONS

Class	# of Observations	Mean Rates & Comparison Test	Mean Times & Comparison Test
ASC	85	86.7 a	857 a
ESC	14	63.9 b	1638 b
SMC	19	80.7 a b	820 a b

Note: Means for classes with the same letter do not differ significantly at alpha = .05.

Interest Assessed (INTEREST). The ANOVA results for the variable INTEREST are presented in Table 25. The p-values for both models suggest that at the $\alpha = .05$ level, the hypothesis that the mean sustention rate and mean disposition time are equal regardless of whether or not an interest charge is assessed is rejected. While the R-squared values are relatively low, this variable does contribute somewhat to the explanation of both sustention rates and disposition times.

TABLE 25

INTEREST ASSESSED - ANOVA RESULTS

Model	DF	F-Value	P-Value	R-Squared	Diff. in μ?
Sustention Rate	1	9.03	.0033	.072203	Yes
Disposition Time	1	4.88	.0291	.040387	Yes

Note: Disposition Time model weighted by $1/\sigma^2$ to equalize variances.

The mean comparisons in Table 26 show that sustention rates are lower and disposition times shorter for cases in which interest was assessed. The disposition time data provide evidence that the TINA amendment assessing interest appears to have been effective in motivating faster settlement of defective pricing cases.

TABLE 26

INTEREST ASSESSED - MEAN COMPARISONS

Class	# of Observations	Mean Rates & Comparison Test	Mean Times & Comparison Test
Yes	56	90.7 *	791 *
No	62	76.1 *	1081 *

* The means for these classes are significantly different from the means for all other classes at alpha = .05.

RPA Revisions (RPA_REVS). The results of the one-way analyses using RPA_REVS as the predictor variable for sustention rate and disposition time are presented in Table 27. For this variable, there is a significant difference in the means for disposition times but not for sustention rates. Similarly, the R-squared values indicate that whether or not the RPA has been revised explains about 11% of the variation in disposition times and less than 1% of the variation in sustention rates.

TABLE 27

RPA REVISIONS - ANOVA RESULTS

Model	DF	F-Value	P-Value	R-Squared	Diff. in μ?
Sustention Rate	1	1.03	.3117	.008820	No
Disposition Time	1	14.72	.0002	.112592	Yes

In Table 28, the comparison of means data confirm the expectation that disposition times are longer when the RPA is revised. While these revisions may be necessary, the evidence shows that they do lengthen the disposition time by an average of almost 500 days.

TABLE 28

RPA REVISIONS - MEAN COMPARISONS

Class	# of Observations	Mean Rates & Comparison Test	Mean Times & Comparison Test
Yes	57	N/A	1199 *
No	61		705 *

* The means for these classes are significantly different from the means for all other classes at alpha = .05.

Summary of Analysis of Variance Results. The analysis of variance results for each of the factors considered to affect sustention rates and disposition times were presented above. The results of the F-tests and analysis of the R-squared values were used to assess the extent to which each variable contributes to the explanation of sustention rates and disposition times. The Bonferroni comparison of means tests for sustention rates and disposition times for all factors are summarized in Tables 29 and 30.

TABLE 29

SUSTENTION RATE MEAN COMPARISONS

Factor	Class	# of Obs	Mean Comparison Test
Alleged Defect Amount	<200,000	58	89.4 *
	200,000-1,000000	38	88.6 *
	≥1,000,000	22	56.6 *
Cost Element	Material	61	87.3 a
	Labor	13	85.8 a
	Other	13	73.7 a
	Multiple	31	82.5 a
Contractor Level	Prime	93	88.1 *
	Subcontractor	25	64.3 *
CO Disagreement with RPA	Yes	29	55.3 *
	No	89	92.1 *
Number of Issues	Single	77	88.0 *
	Multiple	41	73.8 *
Legal Complexity	Complex	45	62.9 *
	Not Complex	73	95.5 *
Offsets	Not proposed	76	81.4 *
	Accepted in Full	17	93.9 *
	Accepted in Part	18	73.7 *
	Not Accepted	7	98.9 *
Method of Disposition	Litigated	3	23.3 *
	Not Litigated	115	84.6 *
Fraud Investigation	Yes	7	81 a
	No	111	83.2 a
RPA Revisions	Yes	57	85.7 a
	No	61	80.6 a
Disposition Time	< 1 Year	32	94.3 *
	1-2 Years	23	85.8 *
	2-3 Years	24	78.9 *
	> 3 Years	39	74.8 *
Identity of Prime Contractor	Boeing	11	59.6 a
	General Dynamics	21	102.1 b
	Loral	10	85.2 c
	Martin Marietta	10	84.9 c
	McDonnell-Douglas	13	88.0 d
	United Tech/P & W	10	77.7 e
	Other	43	78.6 e
Product Center	ASC	85	86.7 a
	ESC	14	63.9 b
	SMC	19	80.7 a b
Interest Assessed	Yes	56	90.7 *
	No	62	76.1 *

* The means for these classes are significantly different from the means for all other classes at alpha = 05.

Means for classes with the same letter do not differ significantly at alpha = .05.

TABLE 30

DISPOSITION TIME MEAN COMPARISONS

Factor	Class	# of Obs	Mean Comparison Test
Alleged Defect Amount	<200,000	58	762 a
	200,000-1,000000	38	958 a b
	≥1,000,000	22	1397 b
Cost Element	Material	61	855 a
	Labor	13	1025 a
	Other	13	930 a
	Multiple	31	1089 a
Contractor Level	Prime	93	911 a
	Subcontractor	25	1063 a
CO Disagreement with RPA	Yes	29	1110 a
	No	89	889 a
Number of Issues	Single	77	758 *
	Multiple	41	1293 *
Legal Complexity	Complex	45	1398 *
	Not Complex	73	664 *
Offsets	Not proposed	76	846 a
	Accepted in Full	17	958 a
	Accepted in Part	18	1199 a
	Not Accepted	7	1305 a
Method of Disposition	Litigated	3	2206 *
	Not Litigated	115	911 *
Fraud Investigation	Yes	7	1354 a
	No	111	918 a
RPA Revisions	Yes	57	1199 *
	No	61	705 *
Identity of Prime Contractor	Boeing	11	768 a
	General Dynamics	21	860 b
	Loral	10	919 c
	Martin Marietta	10	1608 d
	McDonnell-Douglas	13	418 e
	United Tech/P & W	10	761 f
	Other	43	1082 g
Product Center	ASC	85	857 a
	ESC	14	1638 b
	SMC	19	820 a b
Interest Assessed	Yes	56	791 *
	No	62	1081 *

* The means for these classes are significantly different from the means for all other classes at alpha = .05.

Means for classes with the same letter do not differ significantly at alpha = .05.

Model Building

Having identified a set of factors for sustention rates and disposition times through the interview process, the factors were further screened through an analysis of variance. The factors having means significantly different from one another at the 95% confidence level became the initial set of independent variables considered for model inclusion. Disposition Time was subsequently eliminated as a potential independent variable for the sustention rate model. Because the value of Disposition Time is unknown until the case has been settled, it is not useful for prediction. Table 31 summarizes the lists of factors which were used in regression analysis for sustention rates and disposition times.

TABLE 31

FACTORS CONSIDERED IN MLR MODELS

Statistically Significant Factors for Sustention Rates	Statistically Significant Factors for Disposition Times
Alleged Defect Amount	Alleged Defect Amount
Number of Issues	Number of Issues
Legal Complexity	Legal Complexity
Method of Disposition	Method of Disposition
Identity of Prime Contractor	Identity of Prime Contractor
Product Center	Product Center
Interest Assessed	Interest Assessed
Contractor Level	RPA Revisions
Offsets	
CO Disagreement with RPA	

Best Subset Selection. The predictor variables selected using Miller's method, as well as preliminary regression results, are shown in Tables 32 and 33 for sustention rates and disposition times, respectively. From research conducted on Miller's Method, it was expected that a set of variables would consistently be chosen as the best, but this did not happen. Because there were no clear winners from the initial screening, a second screening was performed. This additional screening considered only those variables selected by the initial screening. From this additional screening, the models were selected based on the set of variables which achieved the highest selection rate. A summary of the results for both screenings is included in Appendix E.

TABLE 32

LINEAR REGRESSION RESULTS FOR SUSTENTION RATES

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P	VIF
CONSTANT	99.1594	2.06389	48.04	0.0000	
DISAGREE	-25.9559	4.21653	-6.16	0.0000	1.3
GRAY	-12.7182	3.80535	-3.34	0.0013	1.4
METHDISP	-42.3987	10.4860	-4.04	0.0001	1.1
RPA_LRG	-20.0849	5.05466	-3.97	0.0002	1.3
CENT_ESC	-23.6567	6.07031	-3.90	0.0002	1.2
KTR_MA	21.4356	5.99479	3.58	0.0006	1.2

R-SQUARED	0.7339	RESID. MEAN SQUARE (MSE)	192.727
ADJUSTED R-SQUARED	0.7117	STANDARD DEVIATION	13.8826

SOURCE	DF	SS	MS	F	P
REGRESSION	6	38265.0	6377.50	33.09	0.0000
RESIDUAL	72	13876.3	192.727		
TOTAL	78	52141.4			

TABLE 33

LINEAR REGRESSION RESULTS FOR DISPOSITION TIMES

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P	VIF
CONSTANT	481.886	103.139	4.67	0.0000	
GRAY	441.139	149.013	2.96	0.0041	1.3
RPA_REVS	445.602	136.867	3.26	0.0017	1.2
CENT_ESC	636.470	232.727	2.73	0.0078	1.1
KTR_MC	-577.303	207.853	-2.78	0.0070	1.1
RPA_LRG	555.329	208.065	2.67	0.0094	1.3

R-SQUARED	0.4683	RESID. MEAN SQUARE (MSE)	3.200E+05
ADJUSTED R-SQUARED	0.4319	STANDARD DEVIATION	565.680

SOURCE	DF	SS	MS	F	P
REGRESSION	5	2.057E+07	4.115E+06	12.86	0.0000
RESIDUAL	73	2.336E+07	3.200E+05		
TOTAL	78	4.393E+07			

Verification of Model Assumptions. The tests to check for assumption violations, as outlined in Chapter 3, include tests for heteroscedasticity, non-normality of residuals, and multicollinearity. The following results were found:

Heteroscedasticity. To determine if the residuals had constant variances, the residuals were plotted against the predicted values. The residual plot for sustention rates, shown in Figure 1, has no discernible trend. Therefore, the assumption of constant variances is considered valid. The plot for disposition times, shown in Figure 2, however, appears to have a strong expanding trend. This pattern occurs when the error component increases as the mean increases.

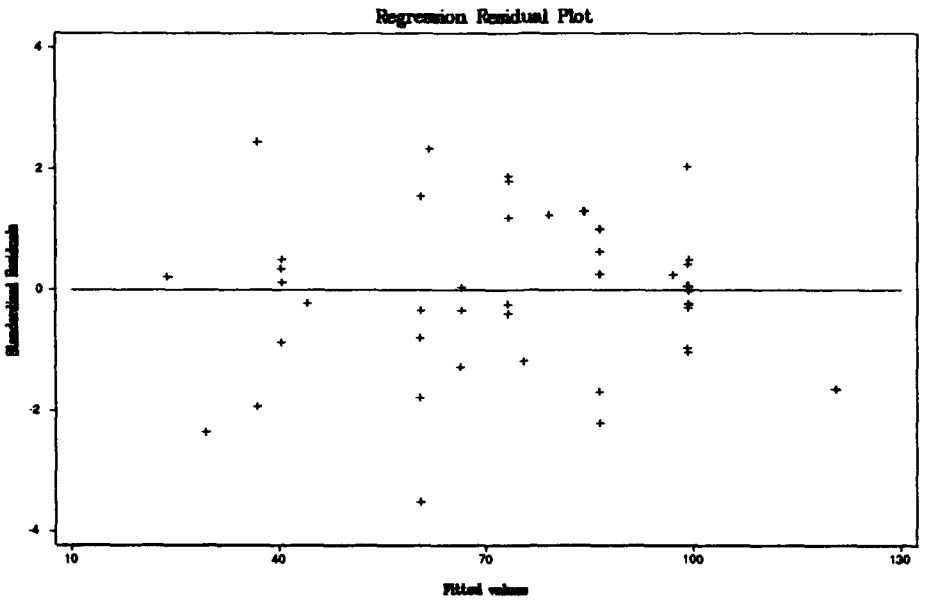

Figure 1. Residual Plot for Sustention Rates

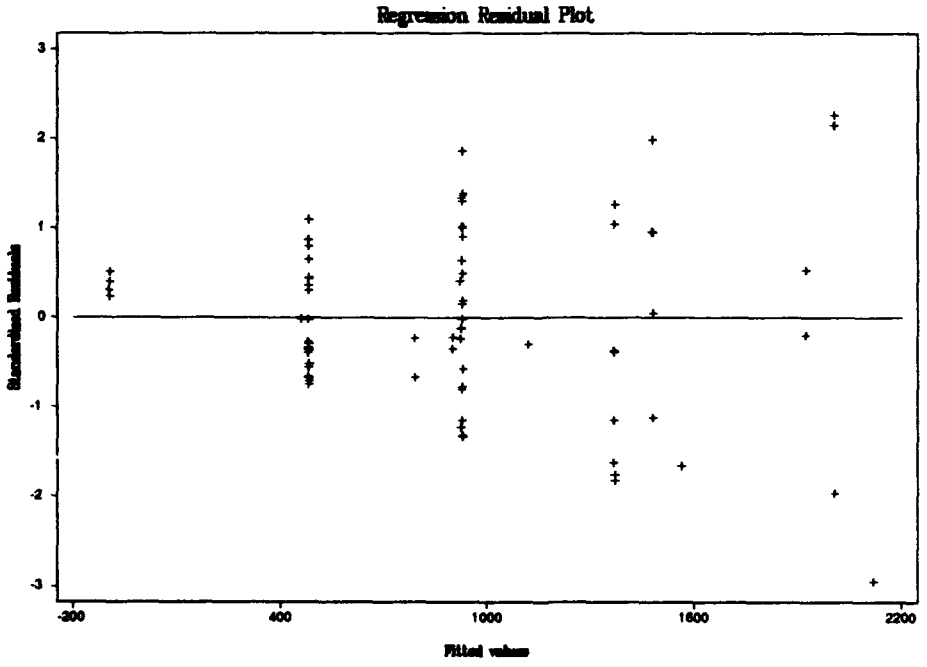

Figure 2. Residual Plot for Disposition Times

To stabilize the residual variance for disposition times, a transformation of the dependent variable (Y) is required. Based on the trend displayed, $\sqrt{Y}$ and log (Y) are the two most suited transformations (McClave & Bensen 685). Transformation $\sqrt{Y}$ did not improve the residual plots, but log (Y) appeared to stabilize the residual variation. The logarithmic transformation improved the residual plots and R^2, but invalidated the selection of the CENT_ESC variable. Because the p-value of CENT_ESC increased from 0.0078 to 0.2048 after the transformation, CENT_ESC was no longer a useful predictor variable. To explain why this might have occurred, a regression line of the predictor variable CENT_ESC was plotted before and after the logarithmic transformation. The regression lines showed that CENT_ESC was initially linear, but the logarithmic transformation caused CENT_ESC to become a nonlinear predictor. Therefore, CENT_ESC was eliminated from the disposition time model. Table 34 displays the linear regression results, without the predictor variable CENT_ESC, of the logarithmic model correcting for heteroscedasticity. Figure 3 shows the corrected residual plot for the regression model displayed in Table 34.

TABLE 34

LINEAR REGRESSION RESULTS FOR DISPOSITION TIMES
WITH LOGARITHMIC TRANSFORMATION

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P	VIF
CONSTANT	2.54091	0.05882	43.19	0.0000	
GRAY	0.25417	0.08455	3.01	0.0036	1.2
RPA_REVS	0.33446	0.07655	4.37	0.0000	1.1
KTR_MC	-0.47130	0.11821	-3.99	0.0002	1.1
RPA_LRG	0.37985	0.11874	3.20	0.0020	1.3

R-SQUARED	0.4849	RESID. MEAN SQUARE (MSE)	0.10422
ADJUSTED R-SQUARED	0.4570	STANDARD DEVIATION	0.32284

SOURCE	DF	SS	MS	F	P
REGRESSION	4	7.25966	1.81491	17.41	0.0000
RESIDUAL	74	7.71284	0.10422		
TOTAL	78	14.9725			

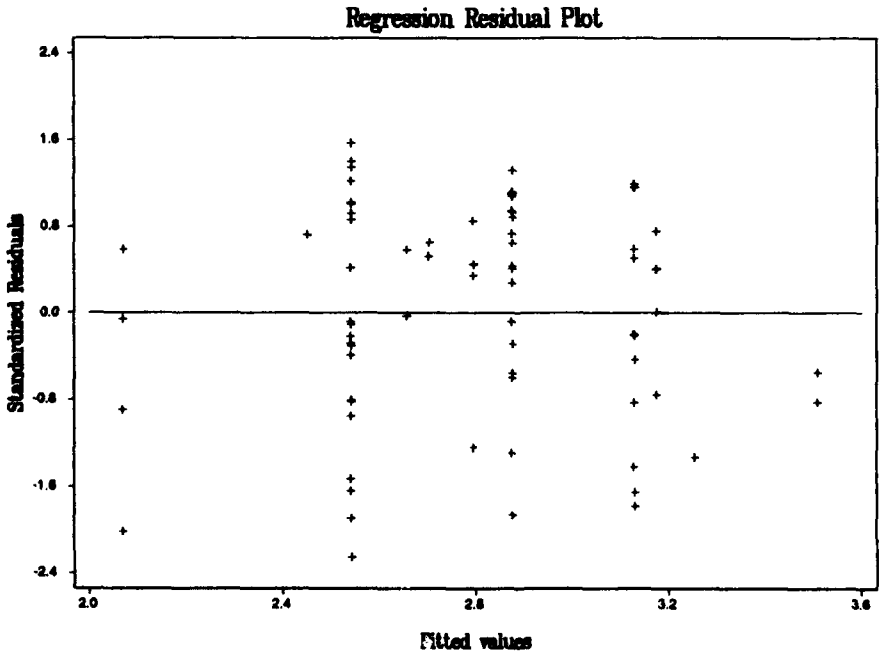

Figure 3. Residual Plot for Transformed Disposition Times

Normal Distribution of Residuals. The test for non-normality of residuals was accomplished by constructing a Wilk-Shapiro/Rankit Plot. The rankit plot for disposition times is shown in Figure 4. Because the plots appear to be in a relatively straight line and W' Statistic 0.9524 is greater than the selected standard of 0.9000, the assumption of normally distributed residuals is not rejected.

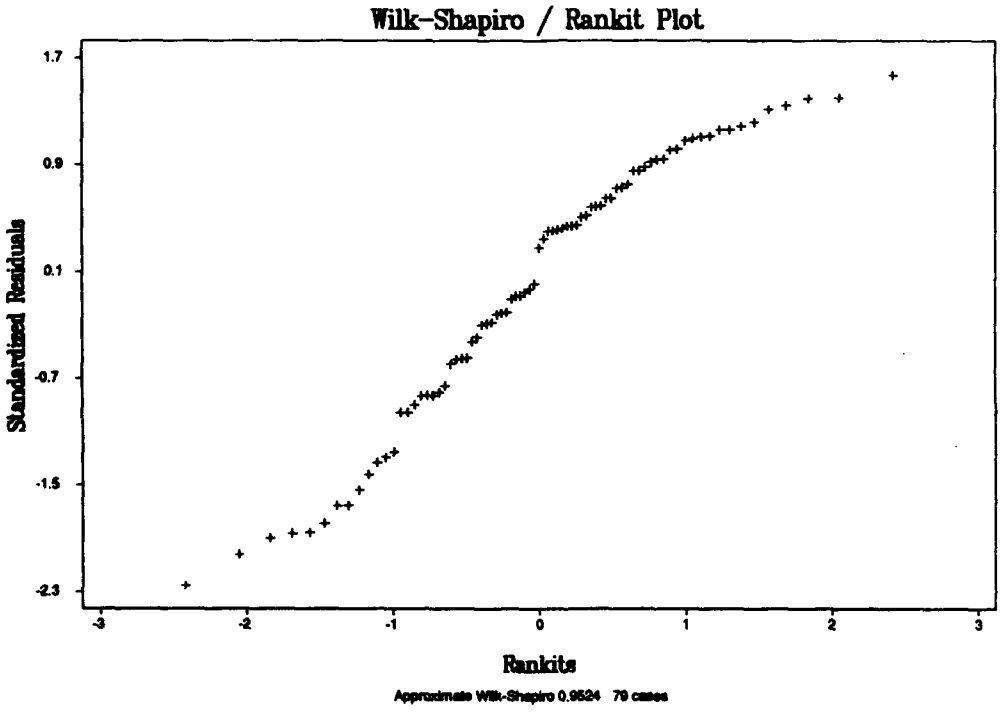

Figure 4. Wilk-Shapiro/Rankit Plot for Transformed Disposition Times

The rankit plot for sustention rates is shown in Figure 5. Although W' Statistic 0.9072 > 0.9000, the plots do not conform well to a straight line. To better understand why the residual plots deviate from a true straight line, a histogram of the studentized residuals was created (Figure 6). Although the histogram was somewhat normally shaped, the quantity of residuals between 0.0 and 0.6 standard deviations was unusually high. This is due to

the nature of the sustention rate data. Because approximately half of the sustention rate values are 100%, it naturally increases the quantity of residuals within a particular standard deviation. Based on the explanation provided by the histogram and the W' Statistic exceeding the established standard of 0.9000, the assumption of normality is not rejected.

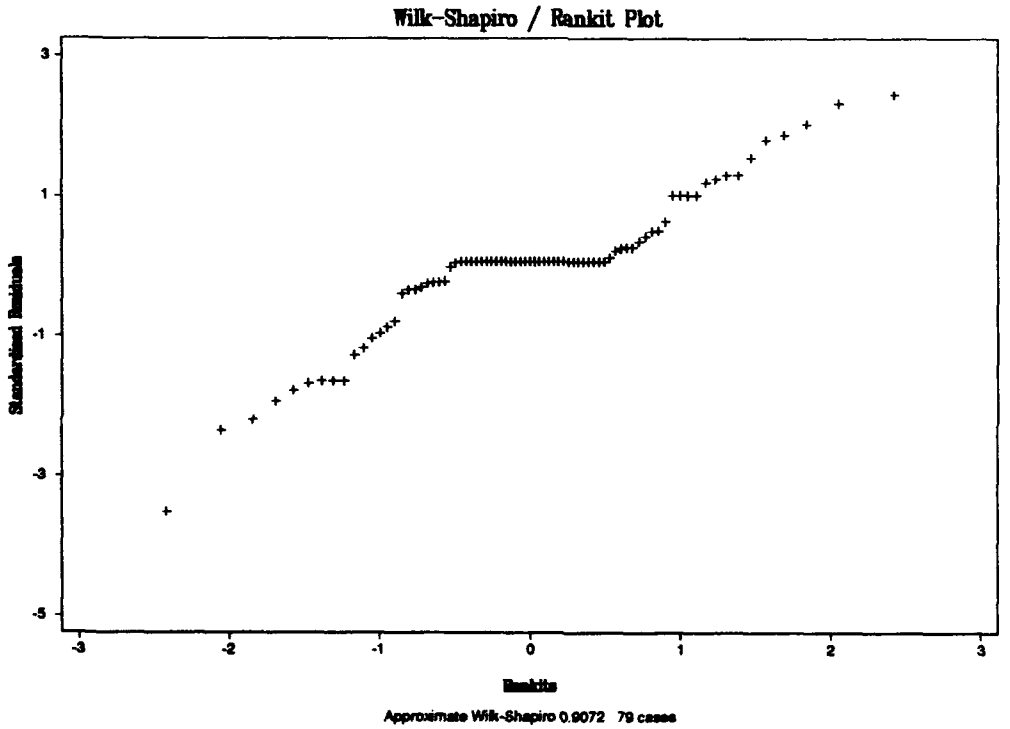

Figure 5. Wilk-Shapiro/Rankit Plot for Sustention Rates

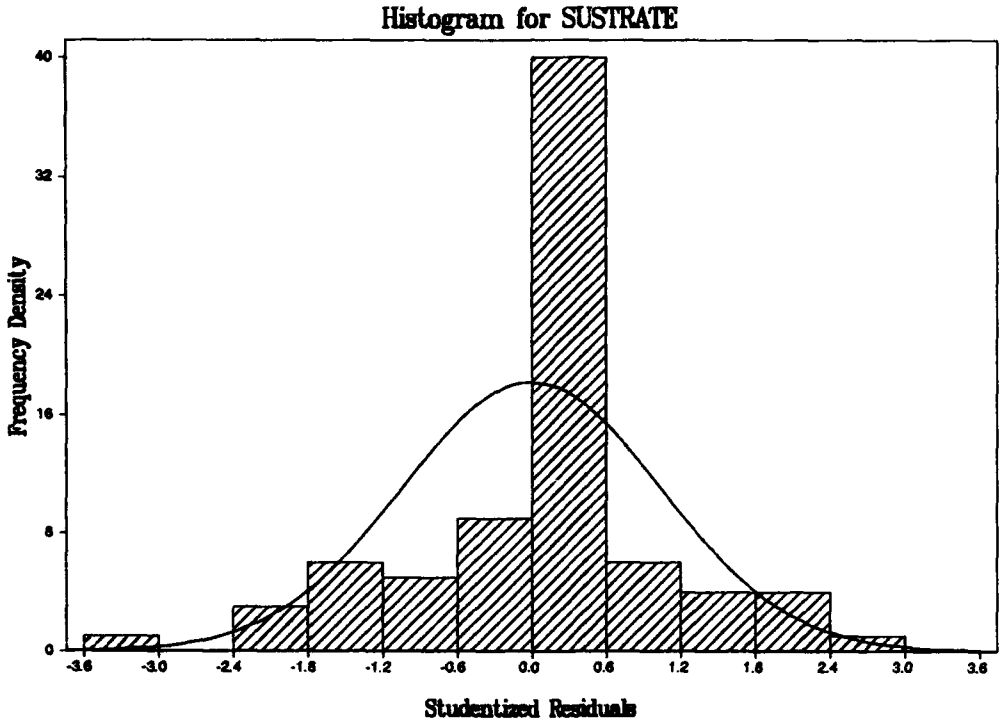

Figure 6. Histogram of Studentized Residuals for Sustention Rates

Multicollinearity. During model building, none of the indicators of multicollinearity were detected. The models did not show a large R^2 value and F-Statistic, with small individual t-values, nor large changes in the estimated coefficients when a variable was added or deleted, nor large variance inflation factors. The VIFs for both models, displayed in Tables 33 and 35, are well below the maximum 10.0 VIF often taken as an indicator of severe multicollinearity problems (Neter and others, 1985:392).

Model Determination and Evaluation. Because the MLR assumptions were satisfied, the models previously outlined in Tables 33 and 35 were selected as the best predictors for sustention rates and disposition times, respectively. For both models, the p-values, which are the observed significance levels of the F-statistic, are 0.0000. This

indicates that at least one model parameter, β, is useful for predicting sustention rates or disposition times at any significance value greater than zero. This result leads to the conclusion that a significant linear relationship exists between the dependent variables and the combined effects of the independent variables.

The predictor variables used in the sustention rate and/or disposition time models are defined in Table 35 and the regression equations for each model are also provided below.

TABLE 35

PREDICTOR VARIABLES USED IN MLR MODELS

Factor	Variable	Definition
Product Center	CENT_ESC	If ESC then CENT_ESC = 1, else CENT_ESC = 0.
CO Disagreement with RPA	DISAGREE	If Preneg. Obj < RPA then DISAGREE = 1, else DISAGREE = 0.
Legal Complexity	GRAY	If Legally Complex then GRAY = 1, else GRAY = 0.
Identity of Prime Contractor	KTR_MA	If Martin Marietta then KTR_MA = 1, else KTR_MA = 0.
Identity of Prime Contractor	KTR_MC	If McDonnell Douglas then KTR_MC = 1, else KTR_MC = 0.
Method of Disposition	METHDISP	If litigated then METHDISP = 1, else METHDISP = 0.
Alleged Defect Amount	RPA_LRG	If RPA ≥ $1,000,000 then RPA_LRG = 1, else RPA_LRG = 0.
RPA Revisions	RPA_REVS	If RPA revised then RPA_REVS = 1, else RPA_REVS = 0.

The regression equation for sustention rate is:

SUSTENTION RATE = 99.2 - 26.0(***DISAGREE***) - 12.7(***GRAY***) - 42.4(***METHDISP***) - 20.1(***RPA_LRG***) - 23.7(***CENT_ESC***) + 21.4(***KTR_MA***)

The predictor variables are listed in descending order of their contribution to the predictive capability of the sustention rate model. In other words, the variable DISAGREE contributes more to the model's predictive capability than GRAY, and GRAY

contributes more than METHDISP, and so on. The coefficient of determination, R^2, for the entire regression model is 0.7339. This means that the combination of the six selected predictor variables explains 73.4% of the variability in sustention rates.

The coefficients associated with each predictor variable indicate the magnitude by which the dependent variable, SUSTENTION RATE, is affected. For example, if the case is expected to go to litigation, the predicted sustention rate will decrease by 42.4%; if the prime contractor is Martin Marietta, the predicted rate will increase by 21.4%. Therefore, METHDISP has a larger, but opposite effect on SUSTENTION RATE than does KTR_MA. Because all the predictor variables are indicator variables, the model can be used in the following manner: Step 1: Assume an initial sustention rate of 99.2%; Step 2: If the predictor variable is true, subtract or add the variable's coefficient amount; Step 3: Repeat Step 2 until no more predictor variables are true. The end result is a final predicted sustention rate for the particular case being analyzed.

The regression equation for disposition time, as outlined in Table 23, is:

LOG DISPOSITION TIME = 2.54 + 0.25(***GRAY***) + 0.33(***RPA_REVS***) - 0.47(***KTR_MC***) + 0.38(***RPA_LRG***)

As with the sustention rate regression equation, the predictor variables for (logarithmic) disposition times are listed in descending order of their contribution to the predictive capability of the sustention rate model. Therefore, GRAY contributes more than RPA_REVS, RPA_REVS more than KTR_MC, and KTR_MC more than RPA_LRG. The coefficient of determination, R^2, for the entire regression model is 0.4849. This means that the combination of the four selected predictor variables explains 48.5% of the variability in disposition times.

The coefficients associated with each predictor variable indicate the magnitude by which the dependent variable, LOG DISPOSITION TIME, is affected. Thus, McDonnell Douglas' cases have the larger impact on decreasing disposition times; cases with RPAs

over $1M have the largest impact on increasing disposition times. Because a logarithmic transformation of disposition times was necessary to equalize the variances, the coefficient values and, thus, the predicted times will be in logarithmic form. As such, a re-transformation (anti-log) will need to be accomplished in order to determine the predicted disposition time.

Model Validation

One third of the original data that was collected was set aside to investigate the predictive capability of the selected models. The non-fitted data were entered into the regression equations and a predictive R^2 was calculated for each model. The results are provided below in Table 36.

TABLE 36

COMPARISON OF FITTED R^2 AND PREDICTIVE R^2

Model	Fitted R^2	Predictive R^2	Difference
Sustention Rates	0.7339	0.5977	0.1362
Disposition Times	0.4849	0.3292	0.1557

The results indicate a loss of predictive capability for both models when non-fitted data were used. This result is not unexpected given the nature of model building. Approximately 60% and 33% of the variation in sustention rates and disposition times, respectively, were explained by the models when unfitted data were used.

V. SUMMARY AND CONCLUSIONS

Summary

Defective pricing occurs when contractors fail to disclose current, accurate, and complete cost or pricing data in their proposals. Failure to submit valid cost or pricing data entitles the government to a refund in the amount of the overpayment. With the current backlog of overage defective pricing cases and the continuing decline in sustention rates, a better understanding of the underlying factors inhibiting or fostering timely and successful recoupment of defective pricing funds is needed. The purpose of this research was to identify the factors which significantly affect sustention rates and disposition times in defective pricing cases, and determine if valid models could be developed to predict both rates and times.

Research Objectives. The specific objectives of this research were to:

1. Identify factors that are presumed to affect sustention rates of defective pricing cases.

2. Identify factors that are presumed to affect disposition times of defective pricing cases.

3. Determine which factors identified in Objectives 1 and 2 explain the greatest variation in sustention rates and disposition times.

4. Develop and validate a model to predict sustention rates using factors identified in Objective 3.

5. Develop and validate a model to predict disposition times using factors identified in Objective 3.

Methodology and Summary Results. A summary of the methodology and results for each objective are provided below.

Research Objectives 1 and 2. On the basis of a literature review, personal experience, and discussions with defective pricing experts, a list of potential factors affecting sustention rates and disposition times was compiled. To validate this initial set of factors and identify important additional factors, twenty-four interviews were conducted with defective pricing experts. The resulting list of factors, which the interviewees presumed to significantly affect sustention rates and disposition times, is shown in the first two columns of Table 37.

Research Objective 3. The variables found to be significant during the interview process were screened for quantitative analysis. Several factors, such as expertise of participants, workload, and priority, were excluded from further analysis due to the difficulty in collecting data or the inability to determine what type of data should be collected to accurately measure the factor. For the factors which lent themselves to quantification, data were collected on defective pricing cases resolved between 1 March 1991 and 31 March 1994 at ASC, ESC, and SMC. A total of 118 cases were analyzed.

The interview results indicated that offsets and the identity of the prime contractor were considered significant for disposition times, but not sustention rates. Because data were collected on those variables, the statistical effect of offsets and the identity of the prime contractor on sustention rates was also assessed.

For each of the factors meriting statistical analysis, a one-way analysis of variance model was built to determine which factors contributed most to explaining sustention rates and disposition times. The results were evaluated to ascertain which factors showed a statistically significant difference in the factor level means at the 95% confidence level. The statistical evaluation of the factors, compared to the experts' expectations, is presented in column three of Table 37.

TABLE 37

RESULTS FOR RESEARCH OBJECTIVES 1, 2, AND 3

Factor	Experts' Assessment of Effect on Rates and Times	ANOVA Results - Statistical Confirmation of Experts' Expectations
Alleged Defect Amount	Significant	Confirmed
Cost Element	Significant	Not Confirmed
Contractor Level	Significant	Confirmed for Rates Only
CO Disagreement with RPA	Significant	Confirmed for Rates Only
Number of Issues	Significant	Confirmed
Legal Complexity	Significant	Confirmed
Offsets	Significant for Times Only	Not Confirmed, but Statistically Significant for Rates
Method of Disposition	Significant	Confirmed
Fraud Investigation	Significant	Not Confirmed
RPA Revisions	Significant	Confirmed for Times Only
Disposition Time	Significant for Rates Only	Confirmed
Identity of Prime Contractor	Significant for Times Only	Confirmed - Also Found to be Statistically Significant for Rates
Expertise of Negotiators	Significant	Not Evaluated
Product Center	Significant	Confirmed
Workload	Significant	Not Evaluated
Priority (Decent. Offices)	Significant	Not Evaluated
Interest Assessed	Significant	Confirmed
Audit Characteristics	Significant	Not Evaluated
Assist Audits	Significant	Not Evaluated
Quality Documentation	Significant	Not Evaluated
Expertise of Participants	Significant	Not Evaluated
Personnel Turnover	Significant	Not Evaluated
Management Attention	Significant	Not Evaluated

Research Objectives 4 and 5. The factors found to be statistically significant using analysis of variance became the initial set of predictor variables considered for model building. Disposition Time was excluded as a potential predictor variable because the value of Disposition Time is unknown until the case has been settled. Therefore, the

independent variable, Disposition Time, is not useful for prediction. Using multiple linear regression techniques, the models shown below were selected as the best predictors for sustention rates and disposition times. The chosen models explain approximately 73.4% and 48.5% of the variability for sustention rates and disposition times, respectively.

SUSTENTION RATE = 99.2 - 26.0(***DISAGREE***) - 12.7(***GRAY***) - 42.4(***METHDISP***) - 20.1(***RPA_LRG***) - 23.7(***CENT_ESC***) + 21.4(***KTR_MA***)

LOG DISPOSITION TIME = 2.54 + 0.25(***GRAY***) + 0.33(***RPA_REVS***) - 0.47(***KTR_MC***) + 0.38(***RPA_LRG***)

The predictor variables are listed in descending order of their contribution to the predictive capability of the models and are defined in Table 38. In the disposition model, for example, GRAY contributes more than RPA_REVS, RPA_REVS more than KTR_MC, and KTR_MC more than RPA_LRG. The coefficients associated with each predictor variable indicate the magnitude by which the dependent variables, SUSTENTION RATES and LOG DISPOSITION TIMES, are affected. Thus, METHDISP has the largest impact on decreasing sustention rates and RPA_LRG has the largest impact on increasing disposition times.

TABLE 38

PREDICTOR VARIABLES FOR REGRESSION MODELS

Factor	Predictor Variable	Definition
Product Center	CENT_ESC	If ESC then CENT_ESC = 1, else CENT_ESC = 0.
CO Disagreement with RPA	DISAGREE	If Preneg Obj < RPA then DISAGREE = 1, else DISAGREE = 0.
Legal Complexity	GRAY	If Legally Complex then GRAY = 1, else GRAY = 0.
Identity of Prime Contractor	KTR_MA	If Martin Marietta then KTR_MA = 1, else KTR_MA = 0.
Identity of Prime Contractor	KTR_MC	If McDonnell Douglas then KTR_MC = 1, else KTR_MC = 0.
Method of Disposition	METHDISP	If litigated then METHDISP = 1, else METHDISP = 0.
Alleged Defect Amount	RPA_LRG	If RPA ≥ $1,000,000 then RPA_LRG = 1, else RPA_LRG = 0.
RPA Revisions	RPA_REVS	If RPA revised then RPA_REVS = 1, else RPA_REVS = 0.

Because all the predictor variables are indicator variables, the models can be used in the following manner: Step 1: Assume an initial sustention rate of 99.2%; Step 2: If the predictor variable is true, subtract or add the variable's coefficient amount; Step 3: Repeat Step 2 until no more predictor variables are true. The end result is a final predicted sustention rate for the particular case being analyzed. The same methodology applies for disposition times, but because the results for the disposition time model are in logarithmic form, a re-transformation (anti-log) needs to be accomplished to obtain the predicted disposition time.

One third of the original data collected was set aside to investigate the predictive capability of the selected models. The non-fitted data were entered into the selected regression equations and a predictive R^2 was calculated for each model. Approximately

60.0% and 32.9% of the variation in sustention rates and disposition times, respectively, is explained by the models when unfitted data are used.

Conclusions and Findings for Sustention Rates

Based on the research conducted for this thesis, the factors which provide the best overall explanation of sustention rates are discussed below. These factors were identified as statistically significant by analysis of variance techniques. Factors suggested by the experts for which data were not collected may be important in explaining rates and times, but, absent statistical evaluation, no conclusions can be drawn. It is important to note that the following discussion pertains to each factor considered independently, not in combination with the other factors. The regression models provide the best indication of the effect these variables have in combination with one another.

Alleged Defect Amount. Sustention rates decrease as the size of the RPA increases. Cases with an RPA less than $1,000,000 averaged 89%; cases exceeding $1,000,000 averaged only 56.6%. It is believed that the magnitude of the RPA affects the seriousness with which a case is pursued by the contractor. This increased contractor resistance is a precursor to lower settlement amounts, in part due to the government's desire to settle, not litigate, defective pricing cases.

Contractor Level. Sustention rates for cases involving defective pricing at the prime contractor level are an average of 24% higher than those at the subcontractor level. In subcontractor defective pricing there are two interested parties, the prime and the subcontractor. Both parties have a financial stake in the outcome of the case; the subcontractor pays back the amount of overpayment and the prime pays back the burden amount. As such, both parties are likely to provide more resistance to the defective pricing allegations. Increased contractor resistance is a precursor for lower sustention rates.

Contracting Officer Disagreement with RPA. Disagreement with the audit report, measured by whether or not the negotiation objective is less than the final RPA, has a very strong effect on sustention rates. Intuitively, CO disagreement with the RPA leads to lower sustention rates. In fact, the data show that the sustention rate is almost 37% lower in cases involving disagreement. It is difficult to criticize lower sustention rates based on this factor alone, however, because it reflects disagreement within the government on how much the contractor is required to repay. To criticize the contracting officer in such situations is equivalent to assuming that the auditor's position was correct. The presence of disagreement within the government highlights the difficulties in determining whether or not a contractor is liable for defective pricing, and, if so, how much is to be repaid.

Number of Issues. Sustention rates are an average of 14% lower in cases involving multiple issues than those involving only one issue. It is believed that the consolidation of multiple issues into one audit report increases the complexity of the case, making it more difficult for the government to negotiate a full settlement.

Legal Complexity. Sustention rates are much lower for defective pricing cases involving legally complex issues; the average sustention rate for complex cases was 62.9% as compared to 95.5% for non-complex cases. The cases categorized as legally complex involved contractor claims that the data in question were, in fact, appropriately disclosed, that the data did not meet the definition of cost or pricing data, or that the auditor's rationale for calculating the allegation amount was erroneous. Inconsistent case law on these issues paired with poor or missing government documentation made the government's position difficult to defend. Faced with high litigation risk, the government negotiator will often settle the case for less than the full RPA. If the case is litigated, the sustention rate, as discussed below, is likely to be even lower.

Cases categorized as not complex typically involved contractor failure to submit current rates or updated vendor quotes. These cases lack the interpretative ambiguities discussed above and are difficult for the contractor to refute. The auditor usually has evidence of the updated quote and can easily verify whether or not it was submitted. Therefore, the RPA is normally fully sustained.

Offsets. The presence of offset proposals and the government's evaluation of the proposals have a strong effect on sustention rates. Cases in which offsets are not accepted have the highest sustention rates (99%). This result is contrary to the expectation that refused offsets would increase the amount owed by the contractor, thereby increasing his resistance and decreasing the sustention rate. In some of the cases which had rejected offsets, the government had a very sound case. Because the case was so strong, the contractor resorted to submitting unsubstantiated offsets in an attempt to reduce the debt. These offsets were then disallowed, and the contractor paid the full defect amount, resulting in a high sustention rate.

Fully accepted offsets have the next highest sustention rates (94%). Offsets represent an opportunity for the contractor to reduce the amount owed to the government. As such, accepted offsets may lead to reduced resistance from the contractor and higher sustention rates. Cases in which no offsets were proposed have the second lowest sustention rates (81%). It is presumed that in these cases, there were no valid offsets to propose so the contractor could not reduce the amount owed to the government. Because the size of the RPA had not diminished, the contractors increased their resistance to allegation, thereby lowering the sustention rate.

The lowest sustention rates were cases in which the offsets were only partially accepted by the contracting officer (74%). This low rate may be explained by the fact that, in some of these cases, the contracting officer partially accepted an offset that the auditor rejected. When an auditor rejects an offset, his RPA remains unchanged. When a

contracting officer partially accepts an offset rejected by the auditor, there will be a lower sustention rate, by definition.

Method of Disposition. Litigated cases result in much lower sustention rates than do cases settled without litigation. On average, the sustention rate for litigated cases is 23.3%; for cases not litigated, it is 84.6%. Cases that are settled by the boards or courts usually involve complex interpretative issues. Neither the government nor the contractor clearly prevails, so the courts often split the difference.

Disposition Time. Longer disposition times are associated with lower sustention rates. To illustrate, the average sustention rate for cases settled within one year is 94%. In contrast, cases taking more than three years to resolve average only 75%. Contributing factors include the increased probability of lost documentation and personnel turnover as time passes. These factors weaken the government's ability to meet the burden of proof in a defective pricing case and lead to lower sustention rates. As such, disposition times and sustention rates are directly related. Management emphasis on the prompt resolution of defective pricing cases satisfies regulatory requirements, and, more importantly, is associated with higher sustention rates.

Identity of the Prime Contractor. The specific contractor involved in a defective pricing case has an effect on the sustention rate. For the data analyzed, sustention rates ranged from 60% to 102%, depending on the contractor involved. It is believed that corporate culture, attitudes toward defective pricing, and experience with defective pricing affect how companies handle defective pricing allegations. This in turn has a demonstrated effect on sustention rates.

Product Center. The product center resolving the defective pricing case affects sustention rates, and, on average, ESC cases result in lower sustention rates (63.9%) than ASC (86.7%) and SMC (80.7%) cases. Because no statistically significant difference in rates was detected between SMC and ASC, it cannot be concluded that organizational

structure (whether cases are handled on a centralized or decentralized basis) is a contributing factor. The results imply that the differences in sustention rates are driven by factors related to the individual centers, not organizational structures. Such factors include management attention, priority levels, and the nature of the items purchased, including the concentration ratios of the industries involved as well as the specific contractors.

Interest Assessed. The data show that sustention rates are an average of 15% lower in cases where interest was assessed. During the interviews it was suggested that this results from defective pricing amounts being rolled together with interest charges. Oftentimes the contractor will agree to repay a certain total sum which includes both the defective pricing repayment and the interest charge. This bottom-line proposal is rarely more than the original allegation amount. For the government to assess interest, the interest amount must, in effect, be subtracted from the amount sustained. The end result is that roughly the same amount of money is recovered, but in cases assessing interest, the sustention rates are lower.

Conclusions and Findings for Disposition Times

The factors which provide the best overall explanation of disposition times are discussed below, along with any general findings associated with these factors. As for sustention rates, the factors identified as statistically significant by analysis of variance techniques are included. In addition, two factors which were not statistically significant, offsets and fraud investigation, merit additional discussion and are also included.

Alleged Defect Amount. Disposition time increases as the magnitude of the RPA increases. Cases with an RPA exceeding $1,000,000 took an average of 1397 days; cases less than $1,000,000 averaged only 840 days. It is believed that the magnitude of the RPA affects the seriousness with which a case is pursued by the contractor. The greater the RPA, the more aggressive the contractor becomes in refuting elements of the defective

pricing audit. With each contractor rebuttal, additional time is expended by the contracting and audit agencies to evaluate the validity of the contractor's claims. The impact of this reiterative exchange is longer disposition times.

Number of Issues. Cases involving multiple issues took an average of 535 days longer to settle than cases involving only one issue. This is likely due to the fact that each issue becomes, in effect, a separate negotiation.

Legal Complexity. Disposition times are much longer for cases which are more legally complex. In this research, complex cases took an average of twice as long to settle as non-complex cases.

Offsets. Contractor proposed offsets increase the time it takes to resolve a defective pricing case. Cases in which no offsets were proposed took the least amount of time (846 days), offsets proposed and fully accepted by the contracting officer were next (958 days), followed by partially accepted offsets (1199 days), and, finally, offsets rejected in full (1305 days).

While the analysis of variance did not show offsets as statistically significant for disposition times, the experts and researchers believe that offsets do affect times. The disconnect between the statistical test results and expert perceptions may have to do with the timing of submitted offsets. If offsets are submitted before the initial audit is released, disposition times are not affected because disposition time begins when the initial audit is issued. Offsets submitted immediately after the release of the initial audit will impact disposition times, but to a lesser extent than offsets proposed much later in the resolution process. This stems from the fact that the auditor may be reviewing additional comments by the contractor and contracting officer early in the process rather than later. Therefore, offsets proposed earlier in the process lessen the damage to disposition times.

Method of Disposition. Cases which are litigated take, on average, more than twice as long to settle than cases resolved by negotiations, contracting officer final decision, or out-of-court settlements.

RPA Revisions. The data showed that RPA revisions add an average of almost 500 days to the disposition time. After the initial audit is released, fact-finding sessions, discussions with the cognizant contracting officer, and consideration of contractor responses to the allegation of defective pricing often occur. This additional information frequently leads to reconsideration of the case by the auditor and a revision to the RPA. While these revisions are necessary, the evidence clearly shows that they lengthen disposition times.

Identity of Prime Contractor. Who the contractor is has considerable bearing on the time it takes to resolve a case. For the data analyzed, average disposition times ranged from 418 to 1608 days, depending on the contractor involved. Corporate policies, attitudes, and willingness to settle defective pricing cases are contributing elements toward an expedient or lengthy settlement of a case.

Product Center. The difference in disposition times is more affected by the identity of the product center than the type of organizational structure used to resolve defective pricing cases. Cases resolved by ESC (decentralized) took, on average, twice as long as cases resolved by SMC (decentralized) or ASC (centralized).

Interest Assessed. Disposition times are an average of 290 days shorter for cases in which interest was assessed. The knowledge that the amount owed to the government increases over time appears to motivate contractors to settle cases more quickly. The TINA amendment mandating interest payments for defective pricing cases appears to be effective in decreasing disposition times.

Fraud. While the analysis of variance did not show offsets as statistically significant for disposition times due, in part, to the low number of data points, the experts and

researchers believe that offsets do affect times. The descriptive statistics for this research support this belief; cases investigated for fraud added an average of 436 days to disposition times. Of the seven cases investigated, six lacked criminal evidence and were returned to the contracting agency for final settlement. Some of these cases were unnecessarily lengthened by the fact that the investigation had been closed for several months before the contracting officer was notified.

Additional Conclusions and Findings

This research provided additional insight into factors which were believed to significantly effect sustention rates and disposition times, but the analysis of variance did not confirm the experts' beliefs. A short synopsis of those factors not confirmed through statistic analysis is provided below, as well as some additional findings associated with this research.

1. Experts believed that the cost element in which the defect occurred had a moderate or greater effect on sustention rates and disposition times. This belief was not substantiated by the analysis of variance results. The researchers believe that the type of defect, such as failure to submit updated rates or adequately disclose a management decision, is the contributing factor, not where the defect was found. Experts also believed that the contractor level, prime or subcontract, affected both rates and times. The ANOVA results showed that the level substantially affected rates, but not times. The most surprising result was in the area of offsets. Experts believed that offsets had a strong effect on times, but not rates. The analysis of variance results found the opposite to be true. The reasons why this may have occurred were discussed in the previous sections.

2. In her 1988 thesis, Volpe stated that the time it took to process a case was not related to the alleged defect amount. Instead, she found a correlation between processing time and the audited contract amount--the greater the amount, the longer it took to settle the case. The researchers of this thesis found the opposite to be true: disposition times are

related to the alleged defect amount (RPA), and not the audited contract amount. Because the correlation between the audited contract amount and disposition times was so low, -0.0520, Volpe's finding was not substantiated by this research. Interview comments also support the researchers' statistical findings. The experts believe that the value of the RPA is a more critical factor than either the audit contract amount or the ratio of the RPA to the audited contract amount.

3. The multiple linear regression model for sustention rates had a much better predictive capability than the model for disposition times. The researchers believe the omitted factors, such as priority and expertise of defective pricing participants, are key predictors of disposition times, but less influential for sustention rates. This fact emphasizes the finding that factors affecting sustention rates are substantially different than factors affecting disposition times. To improve the predictive capability of a disposition time model, participant expertise, workload, priority, personnel turnover, and management attention need to be examined.

4. For the 118 cases analyzed, sustention rates averaged 83% and disposition times, 944 days or just over 2½ years. The 118 cases did not include 29 cases which had a reported $0 sustention amount, but a non-zero RPA. Including these 29 cases drops the overall sustention rate to 67%, a figure which represents the DoD's method of officially reporting sustention rates. The zero dollar cases were those in which the contracting activity disagreed completely with the auditor's position and did not pursue the defective pricing allegation. ASC disagreed completely with the auditor's position approximately 10% of the time; ESC, 18%; and SMC, 49%. With the dramatic difference in the number of cases not pursued by SMC, the researchers believe that contracting officers may have inappropriately closed cases which were, in fact, legitimate. Taking these cases into consideration, sustention rates fall from 86.7% to 80.1% for ASC; from 63.9% to 55.9% for ESC; and from 80.7% to 39.3% for SMC. Direct measurement of disposition times of

these cases was not accomplished. Therefore, the impact to disposition times is unknown, but given partial data provided in PARS, the researchers believe disposition times would increase if these cases were included. This stems from the fact that these cases often involve disagreements between the contracting officer and auditor on the applicability of TINA, and considerable time is spent by the contracting officer working with the auditor to resolve their differences.

Recommendations for Improving Sustention Rates

This research has provided insight into the factors which affect sustention rates. For some of these factors, awareness of the effect is valuable, but no action can be taken to increase rates. For other factors, changes can be made by the contractor, contracting activity, and audit agency to improve rates. The recommended changes are provided below:

1. The research showed that audit reports containing multiple issues result in lower sustention rates than audits with only one issue. During the interviews, it was recommended that when several complex issues are involved, separate audit reports should be issued for each issue. While this may decrease the complexity of each negotiation and increase sustention rates, the potential increase in audit manpower and total disposition time must also be considered.

2. Because sustention rates are so low for litigated cases, contracting officers should carefully weigh the benefits of litigation and the cost of a less than optimal negotiated settlement. In most cases, compromising in a negotiated settlement will result in a higher sustention rate than litigation. Litigation may still be appropriate, however, to establish precedence on a new or unresolved legal issue.

3. Sustention rates decline steadily as the age of the case increases. Therefore, additional emphasis on prompt resolution of defective pricing cases is required.

4. The research found that sustention rates are lower in cases where the contracting officer disagrees with the audit report. Because of the difficult issues involved, some disagreement within the government is inevitable. In some cases, however, the apparent disagreement is caused by the auditor's reluctance to revise his RPA. Once an audit report has been formally issued, the auditor is committed to that position and may hesitate to revise his position. Increased communication between the auditor, the contracting officer, and the contractor prior to audit issuance can reduce this problem. Doing so allows disagreements to be identified and reconciled while the audit is still in draft form, and therefore avoids formal changes to official positions. This reduces the need for future revisions and the level of disagreement between the auditor and the contracting officer.

In other cases, disagreement and eventual closure of cases with a zero sustention rate are the result of an inappropriate contracting officer decision. Cases closed by the contracting officer may have been, in fact, legitimate cases. To prevent inappropriate closures of defective pricing cases, the researchers recommend that the defective pricing focal point, or some other appropriate individual, review the contracting officer's rationale for not pursuing a defective pricing case.

5. A policy for the consistent recording of RPA revisions should be established. In the cases reviewed, auditors revised their RPAs several different ways, including formal audit supplements, letters to the contracting officer, and telephone or personal conversations. Some of these revisions were reflected in the PARS data system, others were not. Since the sustention rate is computed directly from the final RPA, clear policy on the formality required for RPA revisions is needed to prevent distortion of the statistics.

6. Another administrative recommendation involves the recording of offsets. Inconsistent recording of offsets by the contracting activity has lead to distorted sustention rate statistics. In many of the cases reviewed, the auditor reduced the RPA by the amount

of the accepted offset. In others, the RPA remained unchanged, and the offset was recognized separately as a reduction in the amount to be repaid to the government. While either accounting method is acceptable, contracting agencies must be sure to mirror the auditor's practice when reporting the amount sustained.

Recommendations for Improving Disposition Times

From this research, insight into factors affecting disposition times has been gained. Recommended actions to shorten disposition times are provided below:

1. The DoD currently tracks disposition times from the latest audit report, rather than the initial. Because the average time between the initial and final audit was calculated at 465 days. DoD disregards well over a year's worth of work spent on the resolution of each defective pricing case. This lack of accountability obscures the true time it takes to settle a defective pricing case and the fact that settlement times are considerably worse than reported. Therefore, the researchers recommend tracking disposition times from the initial audit date to ensure more management attention is placed on settling defective pricing cases in a timely manner.

2. To reduce the number of supplemental audits and RPA revisions, contractors and contracting officers should submit their comments to the auditor's preliminary findings prior to the completion of the initial audit report. Contractors should also try and submit any offsets during this period as well. In many of the case files, contractors deferred comments and offset proposals until after the release of the audit report and contracting officers simply did not review the preliminary findings.

3. A reporting mechanism is needed to identify when fraud cases are closed because of insufficient evidence. In these cases, the defective pricing allegation still requires settlement by the contracting agency.

4. For those organizations that resolve defective pricing cases on a decentralized basis, a PCO team may be temporarily assembled to settle cases which are extremely overage or can no longer be assigned to a program office because of program cancellation.

5. To increase the priority placed on defective pricing cases, defective pricing funds should be returned to the program office, instead of the General Treasury. In essence, the program office is being penalized for contractor defective pricing. Program office or centralized defective pricing personnel spend their time recouping overpayments, but those payments are not returned to the program office.

Suggestions for Further Research

1. Because this research was limited to AFMC product centers, the findings can be generalized only for those centers. The researchers recommend a study of AFMC's logistic centers to determine if the product center findings are valid for logistic centers. Similarly, the same research could be conducted on operational contracting cases.

2. This research did not investigate several factors proposed by defective pricing experts, including expertise of defective pricing participants, workload, and priority. Investigation was not accomplished because of the difficulty in collecting data or the inability to determine which type of data should be collected to accurately measure the factors. Because the researchers believe these factors do affect sustention rates and disposition times, further analysis of the omitted factors is recommended.

Appendix A: Defective Pricing Survey

Factors Affecting Defective Pricing Cases

The purpose of this interview is to identify factors affecting sustention rates and disposition times in defective pricing cases. On the basis of several General Accounting Office (GAO) and DoD Inspector General reports and discussions with various defective pricing experts, a list of potential factors was created. From this list, we ask you to evaluate the effect of these factors on sustention rates and disposition times.

Definitions:

Sustention Rate is the percentage of the Defense Contract Audit Agency's (DCAA's) recommended price adjustment (RPA) in its last audit supplement that is sustained during negotiations or litigation.

Disposition Time is the total number of days from the date of the DCAA's last audit supplement to the distribution date of the contract modification.

Scale:

For all questions, please use the following scale:

1	2	3	4	5	U
No Effect	Slight Effect	Moderate Effect	Strong Effect	Very Strong Effect	Unknown Effect

Questions:

CATEGORY 1: Category 1 questions are associated with the defective pricing action.

1.1 What effect does the amount of alleged defect (the auditor's RPA) have on

a. sustention rates? 1 2 3 4 5 I U
b. disposition times? 1 2 3 4 5 I U

1.2 What effect does the proportion of the amount of the alleged defect to the total audited contract action have on

a. sustention rates? 1 2 3 4 5 I U
b. disposition times? 1 2 3 4 5 I U

1.3 Defective pricing occurs within the major cost elements of labor, material, overhead, general and administrative, and other. What effect does the cost element in which the defect occurred have on

a. sustention rates? 1 2 3 4 5 | U
b. disposition times? 1 2 3 4 5 | U

1.4 Defective pricing occurs at the prime contractor and subcontractor level. What effect does the contractor level have on

a. sustention rates? 1 2 3 4 5 | U
b. disposition times? 1 2 3 4 5 | U

1.5 Defective pricing occurs on two types of contract actions: initial contracts and modifications to existing contracts. What effect does the type of contract action have on

a. sustention rates? 1 2 3 4 5 | U
b. disposition times? 1 2 3 4 5 | U

1.6 Contracting officer disagreement with the RPA primarily occurs when the contracting officer determines the audit report to be inaccurate, outdated, inconclusive, or unsupportable. What effect does the contracting officer's disagreement with the RPA have on

a. sustention rates? 1 2 3 4 5 | U
b. disposition times? 1 2 3 4 5 | U

1.7 What effect does the number of defective pricing issues addressed in the audit report have on

a. sustention rates? 1 2 3 4 5 | U
b. disposition times? 1 2 3 4 5 | U

1.8 What effect do proposed contractor offsets have on

a. sustention rates? 1 2 3 4 5 | U
b. disposition times? 1 2 3 4 5 | U

1.9 Defective pricing cases are settled through (1) negotiations, (2) contracting officer final decisions, which were not subsequently litigated, or (3) contracting officer final decisions, which were subsequently litigated in the boards or courts. What effect does the method of disposition have on

a. sustention rates? 1 2 3 4 5 | U
b. disposition times? 1 2 3 4 5 | U

1.10 What effect do fraud investigations have on

a. sustention rates? 1 2 3 4 5 | U
b. disposition times? 1 2 3 4 5 | U

1.11 What effect does the length of time to settle defective pricing cases have on sustention rates?

1 2 3 4 5 I U

CATEGORY 2: Category 2 questions are associated with the contractor or original contract.

2.1 Defective pricing occurs on fixed-price and cost reimbursement contracts. What effect does contract type have on

a. sustention rates? 1 2 3 4 5 I U
b. disposition times? 1 2 3 4 5 I U

2.2 What effect does the total amount of the audited contract action have on

a. sustention rates? 1 2 3 4 5 I U
b. disposition times? 1 2 3 4 5 I U

2.3 Contractor size is defined as large or small. What effect does contractor size have on

a. sustention rates? 1 2 3 4 5 I U
b. disposition times? 1 2 3 4 5 I U

2.4 Contract cost performance is evaluated as an underrun, overrun, or on-target. What effect does cost performance have on

a. sustention rates? 1 2 3 4 5 I U
b. disposition times? 1 2 3 4 5 I U

2.5 What effect does the identity of the prime contractor (e.g., Boeing vs. Lockheed vs. Hughes) have on

a. sustention rates? 1 2 3 4 5 I U
b. disposition times? 1 2 3 4 5 I U

CATEGORY 3: Category 3 questions are associated with human resources.

3.1 What effect does government negotiator expertise in defective pricing have on

a. sustention rates? 1 2 3 4 5 I U
b. disposition times? 1 2 3 4 5 I U

3.2 What effect does contractor negotiator expertise in defective pricing have on

a. sustention rates? 1 2 3 4 5 I U
b. disposition times? 1 2 3 4 5 I U

3.3 In some government organizations, defective pricing cases are dispositioned by resources dedicated exclusively to defective pricing. In others, cases are absorbed into the cognizant contracting officer workload. What effect does the organizational structure have on

a. sustention rates? 1 2 3 4 5 I U
b. disposition times? 1 2 3 4 5 I U

CATEGORY 4: Category 4 questions allow for additional factors to be suggested.

4.1 What factors were not addressed that you believe affect sustention rates?

4.2 What effect do your proposed factors have on sustention rates? 1 2 3 4 5 I U

4.3 What factors were not addressed that you believe affect disposition times?

4.4 What effect do your proposed factors have on disposition times? 1 2 3 4 5 I U

Appendix B: List of Interview Participants

	Name	Organization/Position	Interview Date
1	Capt Gary Shafovaloff	ASC Focal Point	4/18
2	Gregg King	ASC Price Analyst	4/15
3	Cindy Hager	ASC Price Analyst	4/15
4	Mike Quinlin	ASC Price Analyst	4/15
5	Bob Williams	ASC Contracting Officer	4/18
6	Maj Henry Gaudreau	ASC Focal Point	4/15
7	Virgil Hertling	HQ AFMC Focal Point	4/15
8	Eugene Solimine	AFMCLC Attorney	4/22
9	Ron Schumann	AFMCLC Attorney	4/20
10	John McPhearson	HQ DCAA Focal Point	4/25
11	Tom Mohrhaus	Liaison Auditor @ ASC	4/18
12	Scott Gentry	Liaison Auditor @ SMC	4/20
13	Bill Netishen	Liaison Auditor @ ESC	4/29
14	Pat Herrick	SMC Focal Point	4/19
15	Rhonda Colby	SMC Negotiator	4/22
16	Adonijah Edwards	SMC Contracting Officer	4/20
17	Paul Guntarz	ESC Focal Point	4/22
18	Jim McKenna	ESC Contracting Officer	4/22
19	Dick Cooper	ESC Contracting Officer	4/29
20	Dave Hawkins	ESC Contracting Officer	4/29
21	Ed Kerns	ESC Contracting Officer	4/25
22	Suzanne Servis	DoD Inspector General	4/20
23	Michael DiRenzo	DoD Inspector General	4/29
24	Debra Murphy	DoD Inspector General	4/25

Appendix C: PARS Data Sheets

DEFECTIVE PRICING METRIC QUERY: 1 MAR 91 - 31 MAR 94

AUD_REP_NR	ACT CD	TYPE	COST QUEST DL	COST SUSTAINED DL	AUD REPORT DT	RES_ACT_DT	DIS_ACT_DT	LITIGA NR	AGE RES	AGE DIS
4291-92W42030001-S1	006	D	$73,176	$73,176	1993-04-15	1993-05-21	1993-07-20		36	96
1481-93A42097011	006	D	$10,056	$10,056	1993-02-25	1993-06-18	1993-06-18		113	113
3421-90A42098309-001-S1	006	D	$574,488	$574,488	1993-11-30	1993-12-22	1994-03-23		22	113
3421-93A42040002	006	D	$954,647	$954,647	1993-03-30	1993-07-21	1993-07-21		113	113
2120--9L420003-S1	006	D	$78,363	$78,363	1993-10-05	1994-01-28	1994-01-28		115	115
2120-9L420002-9-437-S2	006	D	$27,519	$27,519	1993-09-30	1994-01-28	1994-01-28		120	120
1481-93A42097033	006	D	$80,394	$78,315	1993-07-23	1993-12-22	1993-12-22		152	152
3711-70420106-S4	006	D	$5,692,147	$5,692,147	1992-11-20	1992-11-30	1993-04-28		10	159
1481-93A42097018	006	D	$58,681	$58,681	1993-02-25	1993-03-29	1993-08-17		32	173
1481-93A42097012	006	D	$612,468	$612,468	1993-02-25	1993-03-29	1993-08-17		32	173
3421-92A42097023	006	D	$120,768	$120,768	1992-11-10	1993-01-22	1993-05-06		73	177
3711-90A42097008-S2	006	D	$1,021,453	$1,527,640	1992-10-15	1992-12-02	1993-05-06		48	203
3421-92A42010003	006	D	$955,126	$911,503	1993-06-08	1993-08-25	1994-02-03		78	240
1481-92A42098002	006	D	$2,982,701	$2,982,701	1993-06-17	1993-09-15	1994-02-25		90	253
2141-86G42010111-S1	006	D	$931,873	$931,873	1993-01-03	1993-01-06	1993-09-28		3	268
3711-89A42097013-S1	006	D	$316,728	$316,728	1992-07-02	1992-08-19	1993-04-07		48	279
1481-93A42097017	006	D	$963	$963	1993-02-25	1993-06-18	1994-03-31		113	399
4291-89W42010001-S1	006	D	$186,220	$69,569	1992-09-30	1993-06-28	1993-11-12		271	408
6351-86F42010002-S1	006	D	$861,407	$828,028	1992-12-15	1993-06-21	1994-02-09		188	421
3781-91B42020002-S2	006	D	$396,595	$240,680	1992-08-17	1993-01-12	1993-12-22		148	492
3711-91A42030012	006	D	$103,450	$103,450	1991-10-16	1992-08-19	1993-04-28		308	560
3711-91A42020006	006	D	$2,454,991	$2,454,991	1991-09-11	1993-02-04	1993-04-28		512	595

DEFECTIVE PRICING METRIC QUERY: 1 MAR 91 - 31 MAR 94

AUD_REP_NR	ACT CD	TYPE	COST QUEST DL	COST SUSTAINED DL	AUD REPORT DT	RES_ACT_DT	DIS_ACT_DT	LITIGA NR	AGE RES	AGE DIS
4481-86A42010003-S1	006	D	$1,766,051	$678,776	1992-01-10	1993-11-17	1993-11-17		677	677
7151-91D42040101	006	D	$89,501	$45,000	1991-09-05	1993-01-27	1993-12-02		510	819
1481-91A42097026	006	D	$164,043	$95,050	1991-05-07	1993-06-29	1994-02-02		784	1,002
7361-91N42040010-S1	006	D	$10,881	$5,441	1991-04-02	1991-11-01	1994-03-31		213	1,094
7381-6J420040	006	D	$67,279	$67,279	1990-09-24	1992-06-06	1993-09-30		621	1,102
4171-7M420004-S1	006	D	$4,076,155	$2,733,875	1990-03-23	1993-11-12	1993-11-12		1,330	1,330
1481-8A420015	006	D	$4,027,414	$1,700,000	1988-09-30	1993-10-13	1994-03-10		1,839	1,987
1481-8A420023	006	D	$3,742,566	$1,700,000	1988-09-20	1993-10-13	1994-03-04		1,849	1,991
9988-9A9-88-087	006	D	$6,873,844	$2,000,000	1988-02-16	1993-09-28	1994-02-28		2,051	2,204
AVERAGES FOR REPORT_ACTIVITY_CD = 006										
COUNTS									403	575
31										
SUMS										
			$39,311,948	$27,674,275						
3121-91G42040064-S1	010	D	$60,883	$37,505	1993-05-26	1993-05-27	1993-06-29		1	34
2230-5S420002-S2	010	D	$96,762	$96,762	1993-08-23	1993-08-24	1994-01-11		1	141
2230-6S420001-S3	010	D	$1,162,296	$1,162,296	1993-08-23	1993-08-24	1994-01-11		1	141
2230-6S420002-S2	010	D	$423,318	$423,318	1993-08-23	1993-08-24	1994-01-11		1	141
3121-91G42030008-S2	010	D	$402,431	$402,431	1992-09-30	1992-11-09	1993-04-15		40	197
2743-3F-420-001-S-4	010	D	$800,702	$106,500	1990-11-26	1992-04-19	1994-03-01		510	1,191
7121-7-420014-001	010	D	$272,832	$110,000	1987-06-11	1993-08-20	1994-02-02		2,262	2,428

DEFECTIVE PRICING METRIC QUERY: 1 MAR 91 - 31 MAR 94

AUD_REP_NR	ACT CD	TYPE	COST QUEST DL	COST SUSTAINED DL	AUD REPORT DT	RES_ACT_DT	DIS_ACT_DT	LITIGA NR	AGE RES	AGE DIS
AVERAGES FOR REPORT_ACTIVITY_CD = 010										
COUNTS									402	610
	7									
SUMS										
			$3,219,224	$2,338,812						
6251-90W42010005	018	D	$946,952	$946,952	1993-10-22	1994-01-03	1994-02-03		73	104
6251-92N42097003-S1	018	D	$112,040	$112,040	1993-04-01	1994-02-15	1994-03-30		320	363
4251-87C42040548-S1	018	D	$52,321	$52,321	1992-06-10	1993-05-28	1994-01-24		352	593
AVERAGES FOR REPORT_ACTIVITY_CD = 018										
COUNTS									248	353
	3									
SUMS										
			$1,111,313	$1,111,313						

DEFECTIVE PRICING METRIC QUERY: 1 MAR 91 - 31 MAR 94

AUD_REP_NR	ACT CD	TYPE	COST QUEST DL	COST SUSTAINED DL	AUD REPORT DT	RES_ACT_DT	DIS_ACT_DT	LITIGA NR	AGE RES	AGE DIS
FINAL AVERAGES										
FINAL COUNTS									391	564
	41									
FINAL SUMS			$43,642,485	$31,124,400						

DEFECTIVE PRICING METRIC QUERY: 1 MAR 91 - 31 MAR 94(EXTRACT TABLE)

AUD_REP_NR	ACT CD	TYPE	COST QUEST DL	COST SUSTAINED DL	AUD REPORT DT	RES_ACT_DT	DIS_ACT_DT	LITIGA NR	AGE RES	AGE DIS
1361-7D420102-104-S1	006	D	$241,838	$305,980	1991-08-26	1991-11-01	1992-07-29		67	338
1441-0A420005	006	D	$815,594	$775,000	1990-05-25	1991-11-01	1992-07-09		525	776
6241-8H420004-S2	006	D	$75,972	$68,500	1991-03-05	1991-07-02	1991-07-02		119	119
3761-89A42098037-S1	006	D	$82,928	$82,928	1991-03-28	1991-05-24	1991-05-24		57	57
3421-88A42020002-S2	006	D	$66,573	$66,573	1991-03-22	1991-06-05	1991-06-05		75	75
2141-7C420002	006	D	$1,623,342	$427,093	1986-10-10	1989-08-31	1992-09-30	39396	1,056	2,182
2143-4C420007-99	006	D	$1,890,581	$52,500	1984-06-06	1985-01-07	1993-03-31	30912	215	3,220
2211-92A42099620	006	D	$79,477	$79,477	1992-06-17	1992-08-25	1992-08-25		69	69
2230-9A420003-S2	006	D	$68,963	$39,420	1992-02-26	1992-09-11	1992-09-11		198	198
2460-92A42099002	006	D	$763,000	$650,000	1991-12-03	1992-09-30	1992-09-30		302	302
9709-7F420166-S2	006	D	$133,153	$133,153	1991-12-31	1992-03-30	1992-03-30		90	90
3711-89A42020012-S1	006	D	$86,469	$0	1991-10-16	1991-12-02	1991-12-02		47	47
7261-89P42098022-S1	006	D	$82,861	$59,000	1991-11-22	1992-05-22	1992-05-26		182	186
3391-9F420001	006	D	$1,675,000	$5,000	1980-08-08	1983-09-16	1992-09-30	29016	1,134	4,436
3421-0A420016	006	D	$1,078,057	$539,029	1990-08-31	1992-08-25	1992-08-25		725	725
3421-0A420308	006	D	$3,980,191	$2,500,000	1990-09-27	1992-11-18	1992-11-18		783	783
3421-7A420008-002	006	D	$451,000	$20,000	1979-08-08	1983-05-04	1993-03-31	28489	1,365	4,984
1481-8A-210008	006	D	$748,634	$748,634	1987-09-07	1991-12-02	1992-05-14		1,547	1,711
3421-92A42040020	006	D	$179,482	$179,482	1992-09-21	1992-11-23	1992-11-23		63	63
7261-90P42098001-S1	006	D	$58,789	$47,500	1991-10-28	1992-05-26	1992-05-26		211	211
2271-91W42020003	006	D	$53,204	$53,204	1991-09-26	1991-10-24	1992-04-01		28	188
3581-6C420005-S2	006	D	$463,756	$300,000	1991-02-26	1992-10-23	1992-10-23		605	605

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DEFECTIVE PRICING METRIC QUERY: 1 MAR 91 - 31 MAR 94(EXTRACT TABLE)

AUD_REP_NR	ACT CD	TYPE	COST QUEST OL	COST SUSTAINED OL	AUD REPORT DT	RES_ACT_DT	DIS_ACT_DT	LITIGA NR	AGE RES	AGE DIS
1361-70420108	006	D	$165,218	$155,274	1987-04-29	1991-04-10	1991-04-10		1,442	1,442
1441-0A420007	006	D	$423,058	$171,000	1990-04-20	1991-11-14	1992-04-27		573	738
1481-5A420001-S1	006	D	$1,847,276	$350,000	1989-12-18	1991-11-05	1992-03-09		687	812
1441-8A420002	006	D	$1,142,407	$494,138	1989-09-29	1991-11-14	1992-06-09		776	984
1361-70420133	006	D	$168,629	$168,629	1987-06-26	1991-08-01	1991-08-01		1,497	1,497
1481-7A-210083	006	D	$1,257,103	$1,257,103	1987-09-09	1990-05-16	1992-05-14		980	1,709
2141-9C420001S1	006	D	$680,070	$285,880	1989-07-12	1991-11-19	1991-11-19		860	860
3421-6A420114S1	006	D	$28,223	$0	1987-10-30	1992-01-22	1992-01-22	DCAA	1,545	1,545
3131-6X420304-001	006	D	$48,708	$0	1986-05-20	1991-11-01	1992-03-11		1,991	2,122
3711-8A420110	006	D	$8,875	$0	1988-09-20	1991-04-24	1991-04-24	DCAA	946	946
3511-8G420216	006	D	$522,692	$522,692	1988-05-20	1991-05-21	1991-05-21		1,096	1,096
2311-91A42099104	006	D	$494,887	$475,000	1990-11-13	1991-09-09	1991-09-09		300	300
3761-8A420028-S1	006	D	$463,461	$400,000	1991-09-30	1992-11-05	1992-11-05		402	402
2271-90W42098009	006	D	$1,056,594	$1,056,594	1991-04-17	1991-10-29	1992-04-01		195	350
4811-92F42099901	006	D	$171,307	$171,307	1992-07-30		1993-01-07			161
7261-89F42098013-S1	006	D	$68,091	$68,091	1991-10-25	1991-10-29	1992-07-09		4	258
7261-89P42098014-S1	006	D	$199,255	$137,361	1991-09-04	1992-07-27	1992-07-27		327	327
7311-90W42030003(0345)	006	D	$67,320	$60,588	1990-09-27	1991-11-01	1992-12-04		400	799
1251-90H4203046-0-663-S1	006	D	$93,269	$91,509	1991-09-30	1991-11-01	1992-10-19		32	385
6121-88L42040001-S5	006	D	$93,625	$90,000	1991-02-08	1991-05-03	1991-05-03		84	84
3551-00.420.005/476	006	D	$1,159,435	$1,070,000	1990-12-20	1991-05-22	1991-05-22		153	153
1481-70420801-S2	006	D	$446,615	$440,000	1991-01-16	1991-11-01	1992-01-27		289	376

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DEFECTIVE PRICING METRIC QUERY: 1 MAR 91 - 31 MAR 94(EXTRACT TABLE)

AUD_REP_NR	ACT CD	TYPE	COST QUEST DL	COST SUSTAINED DL	AUD REPORT DT	RES_ACT_DT	DIS_ACT_DT	LITIGA NR	AGE RES	AGE DIS
3711-0A420010-S1	006	D	$589,357	$589,357	1991-11-14	1991-11-29	1992-09-29		15	320
3711-0A420015	006	D	$59,263	$59,263	1990-09-21	1991-11-01	1992-07-31		406	679
3711-0A420019	006	D	$104,504	$104,504	1990-08-15	1991-11-01	1992-08-10		443	726
3711-8A420105-S1	006	D	$154,310	$153,026	1991-08-26	1991-11-01	1992-09-11		67	382
3711-8A420106-S1	006	D	$248,454	$264,758	1991-09-06	1991-11-01	1992-07-29		56	327
3711-8A420112-S1	006	D	$282,593	$297,940	1991-08-26	1991-11-01	1992-09-11		67	382
3711-89A42010001	006	D	$94,038	$84,781	1989-09-19	1991-11-01	1993-01-15		773	1,214
6351-90F42030017	006	D	$345,279	$345,279	1991-08-19	1991-10-30	1991-10-30		72	72
3421-91A42010024	006	D	$255,321	$255,321	1991-08-07	1991-09-16	1991-09-16		40	40
3711-91A42020008	006	D	$592,702	$592,702	1991-09-05	1991-11-01	1992-07-29		57	328
3711-91A42020010	006	D	$212,473	$212,473	1991-08-26	1991-11-01	1992-07-27		67	336
3711-91A42040020	006	D	$96,630	$96,630	1992-08-26	1992-10-27	1993-03-05		62	191
3421-91A42097112	006	D	$57,889	$0	1991-04-08	1991-08-06	1991-08-06		120	120
3421-90A42097113-S1	006	D	$21,868	$21,868	1991-05-22	1991-07-17	1991-07-17		56	56
2120-90L42020-002-1-135	006	D	$163,889	$163,889	1990-12-10	1991-06-21	1991-06-21		193	193
3421-90A42010003-S1	006	D	$554,837	$277,419	1991-06-04	1991-11-01	1991-12-20		150	199
3741-08420005-S2	006	D	$54,455	$36,494	1991-04-15	1992-05-29	1992-05-29		410	410
2311-8A420002	006	D	$42,636	$0	1987-10-20	1991-08-01	1991-08-01		1,381	1,381
3421-0A420307	006	D	$3,741,528	$3,587,834	1990-09-19	1991-11-01	1991-12-19		408	456
3711-91A42040023	006	D	$40,039	$39,186	1991-09-05	1991-11-01	1992-07-23		57	322
3711-91A42040029	006	D	$243,461	$243,461	1991-12-05	1992-11-30	1993-03-22		361	473
3711-92A42010007	006	D	$320,149	$320,149	1992-08-24	1992-10-19	1993-03-05		56	193

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DEFECTIVE PRICING METRIC QUERY: 1 MAR 91 - 31 MAR 94(EXTRACT TABLE)

AUD_REP_NR	ACT CD	TYPE	COST QUEST DL	COST SUSTAINED DL	AUD REPORT DT	RES_ACT_DT	DIS_ACT_DT	LITIGA NR	AGE RES	AGE DIS
1251-90H42030059-0-690	006	D	$3,159,843	$3,159,843	1990-09-25	1991-08-01	1991-08-01		310	310
1251-90H42040066-0-684	006	D	$184,000	$184,000	1990-09-24	1991-06-12	1991-06-12		261	261
1441-0A420003	006	D	$193,582	$193,582	1990-02-28	1991-07-17	1991-07-17		504	504
3711-0A420001	006	D	$183,383	$183,383	1990-06-29	1991-04-10	1991-04-10		285	285
1651-9B420005	006	D	$32,801	$0	1990-06-28	1991-06-13	1991-06-13		350	350
3761-8A420150-S1	006	D	$3,247,501	$2,750,000	1990-03-05	1992-06-15	1992-06-15		833	833
AVERAGES FOR REPORT_ACTIVITY_CD = 006									449	695
COUNTS	72									
SUMS			$40,581,767	$28,814,781						
1461-9-420.028-121	010	D	$1,448,374	$400,000	1990-05-02	1990-11-30	1991-03-31		212	333
7121-7-420001-S1	010	D	$90,183	$90,183	1990-07-23	1990-11-23	1991-03-31		123	251
2745-90H-420-008-S1	010	D	$42,590	$42,685	1991-09-03	1992-03-23	1992-05-06		202	246
7381-9E420034	010	D	$135,078	$135,078	1989-09-12	1990-04-30	1991-03-31		230	565
4211-9N420003	010	D	$255,300	$255,300	1989-09-27	1990-10-15	1991-09-30		383	733
3271-3420003S-2	010	D	$3,517,970	$3,069,535	1985-08-15	1990-04-15	1991-03-31		1,704	2,054
1461-7-420.003-084	010	D	$2,882,180	$975,000	1986-11-12	1990-11-30	1991-03-31		1,479	1,600
1461-8A420.031-232	010	D	$29,266	$29,266	1988-09-12	1990-10-31	1991-03-31		779	930
7361-90U42030134	010	D	$1,350,286	$0	1990-07-03	1992-08-06	1992-08-17		765	776
4541-8A420006S1	010	D	$474,626	$0	1990-10-19	1991-05-07	1992-03-31		200	529
7381-90A42040049-S1	010	D	$14,732	$7,372	1991-02-21	1992-03-27	1992-03-27		400	400

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DEFECTIVE PRICING METRIC QUERY: 1 MAR 91 - 31 MAR 94(EXTRACT TABLE)

AUD_REP_NR	ACT CD	TYPE	COST QUEST DL	COST SUSTAINED DL	AUD REPORT DT	RES_ACT_DT	DIS_ACT_DT	LITIGA NR	AGE RES	AGE DIS
AVERAGES FOR REPORT_ACTIVITY_CD = 010										
COUNTS									588	765
SUMS	11									
			$10,240,585	$5,004,419						
7501-9B420008	018	D	$425,062	$399,671	1989-09-21	1992-08-15	1993-01-05		1,059	1,202
4191-89H42010016-701-S1	018	D	$860,091	$860,091	1993-03-15	1993-03-20	1993-03-30		5	15
4791-89E42010002-S1	018	D	$203,916	$203,916	1992-05-19	1992-08-31	1992-10-18		104	152
7121-91G42020010	018	D	$95,358	$95,358	1991-07-02	1991-09-05	1991-09-05		65	65
7501-7A42005-001	018	D	$248,167	$0	1987-06-30	1991-02-19	1992-03-31		1,330	1,736
4791-9E420008	018	D	$132,850	$132,850	1989-09-29	1992-03-05	1992-05-18		888	962
4461-91A42040002	018	D	$104,793	$0	1991-09-30	1992-01-14	1992-01-14		106	106
7381-0E420055	018	D	$383,410	$55,000	1990-09-28	1991-03-21	1991-06-11		174	256
4191-9H42020005-157	018	D	$600,539	$0	1990-11-30	1992-02-05	1992-04-30		432	517
4791-0H420972-S1	018	D	$97,991	$0	1990-10-23	1992-01-06	1992-01-06		440	440
3121-89G42020021-S2	018	D	$32,098	$32,098	1992-10-19	1993-01-15	1993-03-10		88	142
3131-8A420010-S3	018	D	$2,461,342	$2,196,829	1992-04-10	1992-04-28	1992-06-19		18	70
4791-91H42097038	018	D	$77,661	$0	1991-06-27	1991-09-15	1992-03-31	RETR	80	278
7121-91G42040010	018	D	$95,368	$95,368	1991-07-02	1991-09-02	1992-03-31		62	273
4791-0H420982	018	D	$59,399	$59,399	1990-05-21	1991-08-08	1992-05-21		444	731
4701-7C420001-037	018	D	$162,374	$0	1986-09-24	1987-05-22	1991-05-24		240	1,703
3541-6S420001	018	D	$377,029	$350,029	1987-09-29	1991-05-30	1991-07-30		1,339	1,400
7321-6X420114	018	D	$696,536	$0	1988-05-31	1991-07-08	1991-07-08		1,133	1,133
7321-6X420112	018	D	$1,520,862	$0	1988-05-18	1991-07-08	1991-07-08		1,146	1,146

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DEFECTIVE PRICING METRIC QUERY: 1 MAR 91 - 31 MAR 94(EXTRACT TABLE)

AUD_REP_NR	ACT CD	TYPE	COST QUEST DL	COST SUSTAINED DL	AUD REPORT DT	RES_ACT_DT	DIS_ACT_DT	LITIGA NR	AGE RES	AGE DIS
7321-89X42020112(236)	018	D	$2,956,840	$0	1989-06-12	1991-07-08	1991-07-08		756	756
7321-89X42030125	018	D	$24,743	$0	1989-06-12	1991-07-08	1991-07-08		756	756
7381-0E420002	018	D	$298,162	$0	1989-11-20	1991-06-25	1991-06-25		582	582
7381-0E420004	018	D	$42,815	$10,000	1989-10-31	1991-03-21	1991-06-11		506	588
7321-89X42030113	018	D	$530,803	$0	1989-06-12	1991-07-08	1991-07-08		756	756
7321-89X42030114	018	D	$1,982,013	$0	1989-06-12	1991-07-08	1991-07-08		756	756
7321-89X42030115	018	D	$59,904	$0	1989-06-12	1991-07-08	1991-07-08		756	756
7121-9G420022	018	D	$101,967	$101,967	1990-05-15	1991-05-30	1991-06-27		380	408
4791-0H420017	018	D	$86,713	$86,713	1990-04-30	1991-03-15	1991-05-07		319	372
7381-0E420031	018	D	$63,526	$57,172	1990-09-05	1991-03-21	1991-06-11		197	279
7381-7J420013	018	D	$100,588	$75,345	1989-02-09	1991-03-21	1991-06-11		770	852
7501-8A420015	018	D	$1	$1	1988-09-30	1991-06-19	1991-06-19		992	992
7501-98420003	018	D	$108,609	$108,609	1989-10-27	1991-05-17	1992-02-19		567	845
9988-GAO/NSIAD-88-32	018	D	$2,123,203	$337,704	1987-10-29	1991-05-30	1992-03-06		1,309	1,590
7501-7A420005-001	018	D	$248,167	$0	1987-06-30	1991-06-30	1991-09-23		1,461	1,546
7381-9E420004	018	D	$30,506	$30,506	1989-09-29	1991-05-29	1991-07-10		607	649
7381-9E420005	018	D	$339,405	$0	1989-08-23	1991-04-26	1991-04-26		611	611
7381-9E420013	018	D	$32,279	$0	1989-07-28	1991-06-25	1991-06-25		697	697
7381-9E420019	018	D	$63,549	$0	1989-08-23	1991-04-26	1991-04-26		611	611
7381-9E420030	018	D	$42,837	$0	1989-08-24	1991-06-25	1991-06-25		670	670
7481-8A420011	018	D	$1,366,126	$0	1989-05-04	1991-06-19	1991-06-19		776	776
7381-7J420009	018	D	$2,902,541	$1,369,494	1989-02-08	1991-05-29	1991-07-10		840	882

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DEFECTIVE PRICING METRIC QUERY: 1 MAR 91 - 31 MAR 94(EXTRACT TABLE)

AUD_REP_NR	ACT CD	TYPE	COST QUEST DL	COST SUSTAINED DL	AUD REPORT DT	RES_ACT_DT	DIS_ACT_DT	LITIGA NR	AGE RES	AGE DIS
7321-89X42030116	018	D	$34,142	$0	1989-06-12	1991-07-08	1991-07-08		756	756
7321-89X42030117	018	D	$156,348	$0	1989-06-12	1991-07-08	1991-07-08		756	756
7321-89X42030118	018	D	$1,632	$0	1989-06-12	1991-07-08	1991-07-08		756	756
7321-89X42030119	018	D	$30,032	$0	1989-06-12	1991-07-08	1991-07-08		756	756
7311-8C420010	018	D	$253,027	$0	1988-09-28	1991-08-02	1991-08-07		1,038	1,043
7381-8J420006	018	D	$45,304	$0	1988-09-20	1991-06-25	1991-06-25		1,008	1,008
7381-8J420021	018	D	$1,121,224	$0	1988-05-07	1991-06-25	1991-06-25		1,144	1,144
7381-0E420005	018	D	$58,832	$0	1989-10-31	1991-04-26	1991-04-26		542	542
7381-0E420006	018	D	$97,531	$0	1989-10-31	1991-04-26	1991-04-26		542	542
7381-0E420009	018	D	$67,122	$0	1989-10-31	1991-04-26	1991-04-26		542	542
7381-0E420010	018	D	$63,513	$0	1989-11-20	1991-04-26	1991-04-26		522	522
7321-89X42030120	018	D	$44,853	$0	1989-06-12	1991-07-08	1991-07-08		756	756
7321-89X42030121	018	D	$117,559	$0	1989-06-12	1991-07-08	1991-07-08		756	756
7321-89X42030122	018	D	$1,759	$0	1989-06-12	1991-07-08	1991-07-08		756	756
7321-89X42030123	018	D	$1,499	$0	1989-06-12	1991-07-08	1991-07-08		756	756
7321-89X42030124	018	D	$19,563	$0	1989-06-12	1991-07-08	1991-07-08		756	756
AVERAGES FOR REPORT_ACTIVITY_CD = 018									648	722
COUNTS	57									
SUMS			$24,254,083	$6,658,120						

VIRGIL

DEFECTIVE PRICING METRIC QUERY: 1 MAR 91 - 31 MAR 94(EXTRACT TABLE)

AUD_REP_NR	ACT CD	TYPE	COST QUEST DL	COST SUSTAINED DL	AUD REPORT DT	RES_ACT_DT	DIS_ACT_DT	LITIGA NR	AGE RES	AGE DIS
FINAL AVERAGES									542	711
FINAL COUNTS	140									
FINAL SUMS			$75,076,435	$40,477,320						

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Appendix D: Additional Factors Suggested During Interviews

The additional factors suggested during the interviews can be categorized and summarized as follows:

Interest Assessed. The 1987 amendments to TINA added a provision for interest assessment to encourage prompt resolution by the contractor. To evaluate the impact of this provision, a categorical variable indicating whether or not interest was assessed was included for further analysis.

Audit Characteristics. Several interviewees stated that characteristics of the audit itself were important drivers of sustention rates and disposition times. The factors that were mentioned include the quality and completeness of the audit, the amount of communication and cooperation between all involved parties, and the willingness of the auditor to revise his initial RPA. While direct measurement of these items is difficult, the presence of RPA Revisions captures the essence of all of these factors. The quality and completeness of the audit is also captured in the variable reflecting contracting officer disagreement with the auditor's final RPA. As such, these two factors combined, revisions to the RPA and contracting officer disagreement with the final RPA, encompass the above mentioned suggestions.

Subcontractor Assist Audits. Another audit factor suggested was the number of assist audits conducted in support of a prime contractor audit. Assist audits are audits on subcontractor defective pricing that are incorporated into the audit on the prime contract. The number of assist audits is difficult to ascertain from the available documentation and this factor was not considered for analysis of variance and model building. In addition, the number of audit assists is likely to be highly correlated with the contractor level at which the defective pricing occurred and the number of issues involved, both of which are factors being analyzed.

Contractor Attitudes. Several factors related to the contractor were proposed during the interviews. Included in this group were contractor procrastination in settling cases, willingness to settle, agreement with the RPA, and contractor networking. Contractor networking is the communication among contractors concerning successful methods of resisting defective pricing allegations. All of these factors can affect the speed with which the contractor is willing to settle the case.

Quality Documentation. The quality and availability of government evidence to support its allegation of defective pricing can have a significant effect on disposition times and sustention rates. Lost or poorly documented files severely hinder the government's ability to defend its case. This factor cannot be measured with available data, and was therefore not considered for analysis of variance and model building. Nonetheless, the importance of thorough documentation of all contract actions cannot be overemphasized.

Expertise of Participants. The interview results showed that government and contractor negotiator expertise in defective pricing were significant factors for both sustention rates and disposition times. In addition, the respondents emphasized the effect of all participants in the process. Not only is the expertise of the negotiators important, but so are the expertise, experience, and availability of all support personnel (e.g. buying team, legal, pricing, defective pricing focal points, auditors, technical personnel, and audit liaisons). The resolution of a defective pricing case is a team effort and the outcome is dependent on all parties involved. As with negotiator and contractor expertise, direct measurement of these factors was not possible with the available data.

Personnel Turnover. Personnel turnover can affect sustention rates and disposition times in two ways. First is the availability of personnel involved on the contract action later found to be defectively priced. If available, these individuals can provide personal knowledge of what transpired during negotiations. This familiarity is expected to increase sustention rates and decrease disposition times. The second factor involves personnel

turnover during the time a defective pricing case is open. The need for new personnel to become familiar with the issues is expected to affect both rates and times. Despite its perceived impact, personnel turnover cannot be measured with available data, and was therefore not considered for analysis of variance and model building.

Management Attention. The management attention placed on resolving defective pricing cases was suggested as a significant factor by several interviewees. Management attention can be demonstrated in a number of ways, including training, assignment of focal points, and regular reporting of case information to upper management. It can also be demonstrated at a variety of levels such as the local Director of Contracting, Major Command, Headquarters, Air Staff, GAO, and IG. Management also sets the attitude toward defective pricing and can influence whether defective pricing is perceived as an administrative irritant or an important problem. As with the related factor involving the priority given to defective pricing, the breadth and depth of management attention make objective measurement virtually impossible. Investigation into the differences between centralized and decentralized offices, however, may provide some insight.

Appendix E: Variable Descriptions

The following is a description of the data collected to represent the factors identified in Table 2 for further evaluation. The variable name used in the computer analyses is included in parentheses.

Alleged Defect Amount (RPA). This research was interested in the effect of the magnitude of the RPA on both sustention rates and disposition times. A difficulty was encountered, however, because sustention rate is calculated by dividing the total dollars recovered by the RPA. Since the RPA is part of the equation for sustention rate, there is, by definition, a high correlation between the two. To overcome this, the RPA was measured on a categorical basis as follows: (1) RPA less than $200,000 (2) RPA greater than or equal to $200,000 but less than $1,000,000 and (3) RPA greater than or equal to $1,000,000.

Cost Element (COSTELEM). The cost elements involved in the defective pricing cases were categorized as follows: Labor, Material, Other, Multiple. Categories such as General and Administrative and Overhead were combined into the Other category because of the small number of data points.

Contractor Level (PRIMESUB). This factor identifies which party, the prime contractor or subcontractor, committed the defective pricing. If the prime contractor failed to submit its own data or properly disclose subcontractor data, the defect was held to be at the prime contractor level. If the case involved data not properly submitted to the prime by the subcontractor, the defect was held to be at the subcontractor level. The one case which involved defective pricing by both the subcontractor and the prime contractor was categorized as subcontractor.

CO Disagreement with the RPA (DISAGREE). Contracting Officer disagreement with the audit report was assessed through a comparison of the CO's negotiation objective with the final RPA. An objective of less than the RPA indicates

disagreement. The categorical variable DISAGREE indicates whether or not this situation has occurred.

Number of Issues (ISSUES). This variable recorded whether the defective pricing case involved single or multiple issues. Categorical rather than real number data were used because of the insufficient number of data points within each real number category (e.g., 2 issues, 3 issues).

Legal Complexity (GRAY). GRAY was an indicator variable which specified whether or not the legal issues involved were complex or not. Determining factors included the presence of opinions commenting on the legal sufficiency of contractor and auditor rebuttals, documented evaluation of litigation risk, strong contractor defenses to one of the required proof elements, and an overall assessment of the legal difficulties in meeting the burden of proof in each case.

Offsets (OFFSETS). This categorical variable identified whether offsets were proposed and, if so, how they were evaluated. The categories were: (1) No offsets proposed, (2) Offset(s) proposed and fully accepted by the Contracting Officer, (3) Offset(s) proposed and partially accepted by the Contracting Officer, and (4) Offset(s) proposed and not accepted by the Contracting Officer.

Method of Disposition (METHDISP). This variable categorizes cases according to whether or not they were litigated. Further breakdown into categories such as negotiated, final decision not appealed, final decision appealed but case settled out of court, etc. was infeasible due to the small number of data points in each of the smaller categories.

Fraud Investigation (FRAUD). FRAUD was an indicator variable which recorded whether or not a given case was investigated for fraud.

Disposition Time (TIME). As an independent variable, disposition time was measured on a categorical basis as follows: (1) Disposition time less than or equal to 1

year, (2) Disposition time greater than 1 year and less than or equal to 2 years, (3) Disposition time greater than 2 years and less than or equal to 3 years, and (4) Disposition time greater than 3 years.

Identity of the Prime Contractor (KTR). Contractors involved in ten or more cases were investigated separately. Separate categories were established for each of the following contractors: Boeing, General Dynamics, Loral, Martin Marietta, McDonnell Douglas, and United Technologies/Pratt & Whitney. All others were combined into one category. Such grouping was necessary because it is not statistically meaningful to evaluate a contractor with only a few data points. A fair amount of history with a particular contractor is necessary to accurately assess that contractor's impact on the dependent variables.

Product Center (CENT). The interviews identified organizational structure as an important factor for both sustention rates and disposition times. ASC handles defective pricing cases on a centralized basis while ESC and SMC handle cases on a decentralized basis. The effect of the organizational structure will be assessed through the use of this variable which indicates which center handled the case. If there is a difference between centralized and decentralized offices, there should be significant differences between both ASC and ESC, and ASC and SMC. Evaluating based on the specific product center involved helps to isolate the effect of the organizational structure from the other potential differences between the centers.

Interest (INTEREST). This variable indicated whether or not interest was assessed.

RPA Revisions (RPA_REVS). This was an indicator variable which recorded whether or not the auditor revised the RPA.

Appendix F: Summary of Subset Selection Results Using Miller's Method

SUSTENTION RATES

INITIAL SCREENING (includes all variables identified through ANOVA):

Selection Rate	Variables Selected In Order of Appearance
50%	DISAGREE/GRAY/METHDISP/RPA_LRG/CENT_ESC/KTR_MA
40%	DISAGREE/GRAY/METHDISP/RPA_LRG/CENT_ESC/KTR_MA/OFF_PAR
10%	DISAGREE/GRAY/METHDISP/RPA_LR

FINAL SCREENING (includes the 7 variables selected from the initial screening)

60%*	DISAGREE/GRAY/METHDISP/RPA_LRG/CENT_ESC/KTR_MA
40%	DISAGREE/GRAY/METHDISP/RPA_LRG/CENT_ESC/KTR_MA/OFF_PAR

DISPOSITION TIMES

INITIAL SCREENING (includes all variables indentified through ANOVA):

Selection Rate	Variables Selected In Order of Appearance
40%	GRAY/RPA_REVS/CENT_ESC/KTR_MC/RPA_LRG
30%	GRAY/RPA_REVS/CENT_ESC
20%	GRAY/RPA_REVS
10%	GRAY/RPA_REVS/CENT_ESC/KTR_MC/RPA_LRG/KTR_BO/METHDISP/ KTR_MA

FINAL SCREENING (includes the 5 variables selected from the initial screening)

90%*	GRAY/RPA_REVS/CENT_ESC/KTR_MC/RPA_LRG
10%	GRAY/RPA_REVS/CENT_ESC

* Model Selected

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Captain Tracey D. Kop was born on 18 September 1967 in Biloxi, Mississippi. In May 1989 she graduated from Pacific Lutheran University with a Bachelor of Arts in Mathematics. Upon graduation, she was assigned to Space Systems Division, Los Angeles AFB, California as a Systems Contract Manager. During her initial year, she negotiated numerous modifications to existing satellite and launch vehicle contracts and participated on a Source Selection for the Space Test Experiments Program. She was then transferred to the Defense Support Program Office where she released the Request for Proposal (RFP) for the sole-source, multi-year Block 23 satellite procurement. After two years, she was selected to serve on the Contracting Directorate's staff as the Acquisition Professional Development Manager, responsible for the Directorate's training and certification of the military acquisition work force. In May 1993, she was reassigned to the Graduate School of Logistics and Acquisition Management of the Air Force Institute of Technology. Upon graduation she was assigned to the Aeronautical Systems Center, Wright-Patterson AFB, Ohio.

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